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CAMPBELLOSPHAERA, A NEW GENUS OF THE VOLVOCACEAE

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TWO PLATES AND ONE TEXT FIGURE

Mixed with several other species of Volvocaceae in living material collected at Pasig in July, 1914, there was a globular plant resembling in many respects *Volvox carteri* Stein. I regarded it as representing a new genus, and under the specific name *carteri* there accumulated in my notebook, in the course of months, a mass of data consisting largely of measurements and cell counts supposed to be descriptive of various stages in the life history of the plant. In November, 1916, when a written account of the new genus was nearly completed from the notes, a night session with a living specimen supposed to belong to the species revealed a difference in behavior inconsistent with the most distinctive character of the genus, thus making it evident that my description was a composite, embracing species of two genera. Consequently it has been my task to disentangle the descriptions of these species.

The plant which is the subject of this paper has globular, biciliate protoplasts with no protoplasmic connections. It has gonidia which are differentiated from the somatogenic cells at an early stage in the development of the embryo, and they become so large, before dividing in their turn, that the species may be called *megalogonidiate*. But the distinctive character of the genus is a migration of the gonidia from the outside to the inside of the embryo. In the bowl stage of the embryo they

are on the outside. They pass through the mouth of the bowl (the phialopore) just before closure occurs and form at first a close cluster within the embryo. Then, as the closed body slowly expands, the gonidia migrate forward from the region of the phialopore to take positions distributed within and near the wall of the coenobial cavity. For the genus of which the migratory habit of the gonidia is one of the distinctive characters I now propose the name Campbellosphaera, dedicating it to Douglas Houghton Campbell, whose life has been devoted to research on the life histories of plants as a basis for natural classification.

In the material from which the type specimen has been selected the asexual specimens are more or less ellipsoidal and the gonidial numbers vary from eight downward. The gonidia in each coenobium usually vary in size and are largest near the posterior pole and smallest farthest from that pole. As a rule the larger gonidia segment first and the successively smaller ones later, inversely in the order of their size. In other large-gonidiate species of this family when some gonidia are regularly unlike the others it is the posterior pair or quartette that are the smaller and segment last. As a mark of distinction from such, this species will be described under the name C. obversa gen. et sp. nov., the specific name having reference to the reversed arrangement of the gonidia as compared with other types of Volvocaceae.

Associated with the reversed arrangement of the gonidia, this species presents another character which may well be an additional distinguishing character of the genus. I have observed that the daughters nearer the posterior pole mature earlier and are born earlier than the others, and that all the daughters are born through one opening formed in the posterior pole. According to my observations on closely related genera, in all of them each daughter is born through a separate opening in the wall of the mother coenobium.

In 1896 Meyer, in Germany, described a species under the name *Volvox tertius*. It is nearer to the genus about to be described than to either of the older species of *Volvox*. Unfortunately Meyer gave no figures to show the general aspect of the coenobia, and it is impossible from his description and table of combinations of progeny to form, at this time, a conclusive opinion as to the proper disposal of his species. The form of the somatic cells and their membranes as shown in Meyer's text figures 5 to 7 is remarkably like that of the cells in the anterior part of the coenobium of *C. obversa* and different from

that of other Volvocaceae. But this resemblance may be more apparent than real.

DESCRIPTION OF THE TYPE SPECIMEN

For the type specimen of *Campbellosphaera obversa* the one shown in Plate I, figs. 1 and 2, has been selected. Of twenty-three photographs of this species available at the time of writing this one best exhibits the characters of the genus and species. It is an asexual coenobium containing four embryos and three gonidia. The specimen was fixed with others from the same source in a chrom-acetic acid solution, washed, passed through gradually concentrated glycerin into alcohol, stained in succession with alcoholic Bismarck brown and alcoholic nigrosin, and mounted with a multitude of others in Venetian turpentine.

The material was collected from a pond in Pasay, indicated in my notes by the letter J, September 22, 1915, fixed at 11.30 in the morning on the following day, and stained and mounted during the ensuing season. The specimen was photographed with a magnification of 100 diameters on May 18, 1916 (the negative was accidentally destroyed after the making of two prints), and photographed again with a magnification of 200 diameters on the 23d of the same month. The two photographs show the specimen in the same position but with different levels in focus. Three weeks later, June 15, 1916, the specimen was examined for the purpose of taking descriptive notes and found to be flattened into a discoid form and turned up on edge. Three years later, June 7, 1919, the specimen was found to be almost completely overturned from its position at the time of making the photographs. All it lacks of being completely overturned is that the posterior pole is about 45 microns higher than the anterior pole. The present aspect of the specimen is so nearly an exact reversal of the photographs as to arouse a suspicion that the photographs had been taken on reversed plates. The facts that the two photographs taken on different days agree, and that the specimen was seen on edge, makes it clear that the revolution really occurred.

The coenobium appears to have been somewhat ovoid in form and measured at the time of photographing about 225 by 275 μ. Three years later it measured about 200 μ wide by 235 μ long. The shrinkage thus shown to accompany the hardening of the Venetian turpentine seems to have been confined mostly to the cell membranes of the coenobium.

The protoplasts of the vegetative or somatic cells are round

and about 5 μ in diameter. They lack protoplasmic connections with their neighbors. They number about 2,830. The distance between neighboring protoplasts is about equal to the diameters of the protoplasts. In surface view a rather thick middle lamella, more deeply stained with Bismarck brown, is visible. In profile view the walls of all the somatic cells are seen to be rounded on the outer side, making the surface of the coenobium uneven. The inner membranes do not show plainly.

The specimen contains three gonidia, and four embryos which were formed from gonidia. Two embryos in the posterior part of the coenobium are in the same stage of development, and two embryos about in the equatorial plane are nearly in the same less-advanced stage of development. The three gonidia lie just in advance of the equatorial plane and are all mature and nearly ready for segmentation. They measure in the photograph 47 and 52 μ wide and are slightly flattened. Measurement of the same gonidia in the preparation on June 9, 1919, gave the same figures. Thus the gonidia show practically no shrinkage in three years while the membranes shrank from 11 to 18 per cent in dimensions during that time. The slight flatness of the gonidia is taken to be the first indication of approaching segmentation. The gonidia are highly vacuolate, with a centrally suspended nucleus containing a well-marked nucleolus. The membranes about each gonidium and about each embryo fit rather closely. The equatorial embryos have reached the bowl stage. Each bears eight gonidia on the edge of the bowl. The size of these gonidia indicates that they were differentiated and ceased to divide at about the 64-celled stage of the embryo. The bowl has a somewhat dentate edge with the gonidia in the points of the teeth. The somatic cells are very small, about 1 or 2 μ thick and 4 μ long, and are numerous, about equal in number to the somatic cells of the parent coenobium in the embryo next to the single gonidium, somewhat larger and about half as numerous in the embryo adjoining the pair of gonidia. This appears to indicate that this embryo is at a stage just preceding the last division of the somatic cells. Some marginal cells of the bowl, between the daughter gonidia, seem to be about twice as thick as the other somatogenic cells. This is suggestive of marginal growth of the bowl. The posterior embryos have reached the bullet stage. Their gonidia have entered by the phialopore and the latter has closed. The gonidia are packed too closely in the posterior part of the embryo to be counted.

Close to the posterior pole of the specimen are two half-grown specimens of an endophytic alga, of which one shows plainly in the photograph (Plate I, fig. 1). More mature specimens of *Campbellosphaera* on the same slide bear an abundance of these endophytes in many stages of development.

OBSERVATIONS ON LIVING SPECIMENS

The earliest record in my notes pertaining to this genus relate to observations on living material collected at Pasig on July 30, 1914. Being mixed with larger species it was designated in the notes as "the smaller, spheroidal species of Volvox." The notes under the above date are as follow:

> Collections of this morning show the smaller species with asexual reproduction. Very large gonidia radially vacuolate. Nearly closed daughter spheres with four and eight large cells, probably gonidia, which appear to be [derived from] undivided marginal cells of the saucer or cup stage. [These] migrated inward and became distributed in the * * * sphere. No protoplasmic connections in mother sphere. Cells of daughter very elongate and compactly arranged. External wall of cells of mother sphere very strongly convex on the outer side. Cells of the anterior pole larger and farther apart and with much larger stigmata.

Measurements of three living specimens were recorded under the same date:

> *Specimen 1.*—Coenobium, 430 μ wide by 480 μ long. Somatic cells, spheroidal, 7 μ in anterior, middle, and posterior parts of coenobium. Intercellular distances, 8 to 12 μ, mostly about 10 μ. Cells in an area 180 μ square, 180. Estimated number of cells in coenobium, 3,470. Gonidia spheroidal; 82 by 85 μ, 80 by 81 μ, 86 by 88 μ, 88 by 90 μ, 89 by 94 μ. Daughters, 2; (1) 77 by 100 μ, with four gonidia about 25 μ, forming a close group in one end; space about the daughter 90 by 106 μ; (2) 77 by 100 μ, with four gonidia about 25 μ each also forming a close group in the blunt end; space about the daughter, 115 by 130 μ. Daughters rotating on polar axis.
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> *Specimen 2.*—410 by 460 μ. Cells, about 7 μ (in equatorial region somewhat less). Intercellular distances, about 8 to 10 μ. Counted twenty-six cells in an area 75 μ square. Estimate of number of somatic cells, 2,635. Gonidia measured 42 μ, 52 μ, 64 μ, 64 μ, 64 μ, 72 μ, 57 by 74 μ (about to divide). Daughter, 80 μ collapsed, with eight gonidia about 18 μ in diameter.
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> *Specimen 3.*—410 by 480 μ. Cells, about 7 μ. Intercellular space, 8 to 10 μ. Cells counted in 75 by 75 μ space, 24. Estimate of somatic cells, 2,520. Gonidia; anterior circle, 50 by 60 μ, 54 by 60 μ, 46 by 48 μ, 54 by 56 μ; posterior circle, 72 μ, 72 μ, 62 by 70 μ, 58 by 66 μ.

A record of the movement of the gonidia from the close cluster in the back of the newly closed embryo to a more scattered distribution in the daughter coenobium was made on the same day. In two embryos, at about 11.30 in the morning, the gonidia were

observed closely packed together within the phialopore, and at about 1.30 in the afternoon these same gonidia had passed forward within their spheres and taken up positions apart from one another.

Measurements of a number of less-mature specimens were made on August 4, 1914, from living material collected at Pasig on that day, as follow:

Specimen 4.—325 by 400 μ. Somatic cells, 5 μ (anterior 5 plus). Cells in 8,100 square μ near equator, 50 to 52. Number of somatic cells, about 2,425. Gonidia, 6; 55, 45, 62, 64, 60, and 70 μ.

Specimen 5.—270 by 320 μ. Somatic cells, about 5 μ. Cells in 8,100 square μ near equator, 72. Number of somatic cells, about 2,280. Gonidia 6; 40, 42, 50, 57, 50, and 56 μ.

Specimen 6.—370 by 450 μ. Somatic cells near equator, about 5 μ. Cells in 8,100 square μ, 39. Number of somatic cells, about 2,370. Gonidia, 6; 50, 58, 65 by 73, 58 by 66, 64 by 80, and 64 by 75 μ; some about to divide.

Specimen 7.—255 by 300 μ. Somatic cells near equator, about 4.5 to 5 μ. Cells in 8,100 square μ, 84. Number of somatic cells, about 2,370. Gonidia 6; 36, 40, 43, 43, 46, and 56 μ.

Specimen 8.—380 by 460 μ. Contained about 27 oospores or oospheres evenly distributed in the posterior three-quarters of the coenobium. Oospheres, 28 to 30 μ in diameter.

Specimen 9.—Presented the anterior pole and measured 320 μ in diameter. The four cells about the anterior pole were observed to form a diamond with transverse diameter about equal to each of its four sides. The anterior pole may be identified by the radially symmetrical arrangement of the stigmata about it. Gonidia, 5; 55 to 60 μ; dividing or about to divide.

STAGES AND FORMS IN COTYPE MATERIAL

The cotype material of this species consists of specimens mounted (1) on the same slide, (2) on other slides from the same batch of stained material, (3) on other lots of slides from the same fixation, (4) material from the same collection, (5) material from the same pond at near the same date, and (6) material taken from near neighboring ponds on the same and near dates. On the same slide with the type specimen are nine hundred eighteen other specimens which appear to be of the same species, and one specimen of a *Volvox* species. There are six other slides of the same lot. A sister lot of seven slides differs in having been stained only with Bismarck brown, the treatment with alcoholic nigrosin solution having been omitted. The following data descriptive of specimens 10 to 18, inclusive, are from the slide bearing the type specimen:

To show the maximum number of gonidia and embryos, namely, 8, and also to show the appearance of the embryos after

their gonidia have begun to separate, the specimen (No. 10) shown in Plate I, fig. 3 was photographed. It measured about 280 by 295 μ, and an estimate of the number of somatic cells is 2,675. The figure shows the anterior pair of embryos youngest, in the bullet stage. About in the equatorial plane is an anomalous pair consisting of a gonidium in the background and a more advanced embryo in the foreground. In the posterior quarter of the coenobium the micrograph seems to show an anomalous quartet, of which the embryo at the right is clearly the most advanced in development of all in the coenobium. Partly behind it appears a bullet embryo, and at the left a smaller gonidium. The fourth member of the quartet must have been a foreign body behind the coenobium, for now it cannot even be found near the specimen. Since being photographed the specimen has separated from its neighbor, rotated so as to present the posterior pole, and shrunken to the extent of diminishing the transverse diameter from 290 μ to 214 μ. The gonidia show no shrinkage, but give slightly larger measurements, which may be attributed to more careful adjustment of the microscope. They are about 50 and 56 μ in diameter.

The extent to which the daughters and their gonidia develop before birth is shown in Plate I, fig. 4. This specimen (No. 11) now lies in almost exactly the position in which it was photographed. But its dimensions have decreased from 315 by 380 μ to 295 by 355 μ. The thickness of the specimen at the present time measures, with an allowance of 1.4 for the optical density of the Venetian turpentine, about 260 μ, which indicates practically no flattening from cover pressure.[1] The somatic protoplasts of the mother measure about 5 μ. The characteristic convexity of the outer side of the membrane of the somatic cells is clearly exhibited under the microscope, especially in the optical sections of the protrusions caused by the pressure of the daughters. The convexity is such that the plane of the base of the dome often intersects the protoplast below the middle; that is, more than half of the protoplast lies within the dome. The spacing of the cells is estimated to be now about 10.8 μ. This, with 315 μ taken as the mean diameter for the coenobium, gives us 3,080 for an estimate of the number of cells. The gonidia of the daughter were counted by carefully focusing with a high-power objective. The daughters number 7; and the gonidia in five of them are 8; in one, 7; and in one, 6. In four of the

[1] The cover glass is supported by glass rodlets of the following thicknesses; 346, 347, 373, and 378 μ.

daughters it could be easily seen that the posterior gonidia are larger than the others. The largest and the smallest gonidia in each daughter were measured and the range of diameters found to be from 18 to 38 μ; the largest minimum, 28 μ; and the smallest maximum, 29 μ. This specimen contains a number of endophytic algae in various stages of development.

An arrangement of the gonidia in three symmetrical pairs is shown by Plate I, fig. 5, a photomicrograph of a coenobium containing a posterior pair of embryos and two pairs of gonidia. This specimen (No. 12) measured at the time of taking the photograph about 255 by 290 μ. Its appearance after three years is so altered by shrinkage and rotation that several hours were lost in hunting for it. It was found to have rotated about a quarter turn to the right and to have shrunken to about 175 by 210 μ. The somatic protoplasts are a little over 5 μ in diameter, but the thickness of the membrane between the protoplasts is reduced to about a micron, making the average cell diameter about 6 μ. This gives 3,520 for the estimate of the number of cells. The gonidia still measure, as in the photograph, about 55 by 60 μ. One of the anterior pair is slightly smaller than the others. The two embryos are nearly but not exactly at the same stage, the daughter gonidia being in the act of entering through the phialopore in one, and having accomplished the entry in the other.

The relative frequency of the different numbers of gonidia in the coenobia on the type slide was estimated by counting the gonidia, or the gonidia and the embryos, or the daughters, in coenobia which had not released any daughters. For this purpose a strip across the middle of the slide was passed in view until a hundred counts had been made. There were found:

1	coenobium	containing	3	gonidia or daughters.
1	coenobium	containing	4	gonidia or daughters.
2	coenobia	containing	5	gonidia or daughters.
34	coenobia	containing	6	gonidia or daughters.
32	coenobia	containing	7	gonidia or daughters.
30	coenobia	containing	8	gonidia or daughters.
100				

On this slide, though the nine hundred coenobia were all passed in view twice and many parts of the preparation were seen many times, no mother coenobium was observed to contain any but asexual daughters; that is, daughters containing gonidia.

There are six sexual coenobia on the type slide. One of these (specimen 13) is shown in Plate I, fig. 6. In the photograph it

measures about 250 by 300 μ. In June, 1919, it measured 230 by 285 μ. The somatic protoplasts are about 5 μ in diameter and the total cell width is about 10 μ. The estimated number of somatic cells is 2,200. The general appearance of the somatic cells and their membranes resembles that of the asexual coenobia at about the time when the gonidia divide. At the present time the radial dimension of the somatic cells varies from about 20 μ between the oospores to about 10 μ over the spores, grading gradually from one size to the other. The protoplasts in all the cells lie close to the convex or rounded outer end of the somatic prisms. There are present twenty-three reproductive cells which are scattered throughout the coenobium just under the somatic layer except for a small vacant space about each pole and another on each side of the coenobium. Applying the simplest interpretation to them, I will call four dark ones, with thin walls and diameters of about 37 μ, oogonia; and nineteen paler ones, with thick walls and diameters of about 42 μ, oospores. The protoplasm of both these kinds of cells is much denser than that of the gonidia in any stage of the latter that has been observed. Vacuoles are practically absent and the nucleus is not evident. The thickened wall of the oospores fits loosely and in optical section is wavy from reticulate wrinkles. The spore wall seems to hinder the penetration of stains and other reagents. An oogonium and two oospores from this coenobium were photographed with a magnification of 400 diameters and they are shown in Plate I, fig. 7. I have closely inspected this specimen, and the six other specimens on the same slide, for vacancies in the pattern of somatic cells and protoplasts which might represent the sites, either of cells that became oogonia, or of cells that had formed antheridia. I found only one vacancy. It appears to be a somatic cell membrane of about one and a half times the usual diameter, containing in place of a protoplast a cavity of about one and a half times the diameter of the average protoplast. It lies beside (not directly over) one of the oospores on the upper face of the coenobium. I am unable to attach any particular significance to it. There is a number of endophytic algae present in the somatic layer. The layer is somewhat battered and broken, and one or more of the oospores seem to have been fixed when about to make their escape. Each of the neighboring coenobia in Plate I, fig. 6, contains seven gonidia.

A younger sexual coenobium (specimen 14) on the type slide is shown in Plate I, fig. 8. It contains twenty-nine reproductive

cells, of which twelve with diameters of about 29 μ are darker and thin walled, and sixteen with diameters of about 34 μ are lighter in color (they appear to have taken up some Bismarck brown but no nigrosin) and enveloped with walls which vary in thickness and in closeness of fit, the thicker ones fitting their protoplasts more loosely, and all having reticulations developed as ridges. One thin-walled reproductive cell on the far side of the coenobium is smaller, about 25 μ, and lighter colored than the others, and may possibly be an endophyte. The coenobium measured about 250 by 275 μ when it was photographed and now is 230 by 255 μ. The somatic protoplasts have diameters of about 4 to 5 μ and are in the outer rounded ends of their prismatic membranes. The average cell diameter is about 9.4 μ. The estimated number of somatic cells is 2,300. That this coenobium is younger than the one shown in Plate I, fig. 6, is evident, not only from the larger proportion of oogonia to oospores, but from the incomplete development of the oospore walls. The large number of relatively less-mature endophytic algae also marks this coenobium as younger than the other. The reproductive cells are absent about the anterior pole, and to a lesser extent about the posterior pole, though the latter point is more evident in the present position of the coenobium than in that which it occupied at the time when the photograph was taken. The radial dimensions of the somatic-cell membranes does not reach the size of those in the preceding specimen.

Notes on the four other specimens of sexual coenobia on the type slide, taken in June, 1919, follow:

Specimen 15.—Coenobium ovoid, 235 by 245 μ. Anterior end larger. Somatic prisms about 20 μ radial dimension about the anterior pole. Oogonia, 28; 39 μ, with central nucleus; a zone of dark bodies, possibly chromatophores, about one-fourth or one-fifth radius from the periphery and one-half or three-fifths radius from the center of the protoplast.

Specimen 16.—Coenobium, 210 by 270 μ. Somatic protoplasts, about 5 μ. Average cell diameter, about 10 μ. Estimate of somatic cells 1,920. Reproductive cells, 23. Oogonia, 16; 30 to 35 μ. Oospores, 7; protoplasts, about 32 μ, walls about 40 μ. Each oogonium has a central nucleus and dark bodies in the outer half of the radius. The oospores have a small central nucleus or nucleolus. Two have walls almost smooth. The protoplasts are eccentric. Three oogonia and one oospore appear more or less disorganized and are surrounded by fungus hyphae.

Specimen 17.—Coenobium, 260 by 295 μ. Cells, about 2,330. Reproductive cells, 25. Oogonia, 2; 32 and 35 μ. Oospores, 23; grading from dark to light, 19 being darker and 4 lighter, the latter nearer maturity. Ridges on spores high. Most spores with nucleus eccentric, twice as far from one side as from the opposite.

Specimen 18.—270 by 340 μ. Somatic plastids, about 5.3 μ. Somatic cells, about 11.9 μ; number, about 2,660. Oogonia, none. Oospores, 17; outer wall, 44 μ; protoplast, 37 μ, eccentric.

A sexual coenobium (specimen 19) containing both oogonia and antheridia is shown on Plate I, fig. 9, a micrograph taken June 18, 1919, from another slide (No. 4) of the same lot as the type slide (No. 2). It measures about 180 by 195 μ. The diameter of the somatic protoplasts is about 5 μ, and of the cells including the membranes 7.1 μ. The estimate of the number of somatic cells is 2,460. There are present in the coenobium 25 oogonia and 3 antheridia, together with two masses of matter which may represent disseminating antheridia. The oogonia are about 24 μ in diameter. The antheridia are platelets 33, 34, and 36 μ wide, and about 6 μ thick. They are more or less convex on what I take to be the ciliated side. All three present edge views. One is on the right side near the anterior pole, one on the right side near the equator, and one on the left side midway between the equator and the posterior pole. The count of cells in the median optical section of a platelet is about 14, which number corresponds aproximately to the diameter of a platelet containing 128 spermatozoids. The distribution of the reproductive organs in the coenobium is as follows:

Anterior quarter	1 oogonium.	1 antheridium.
Second quarter	11 oogonia.	0 antheridium.
Third quarter	7 oogonia.	2 antheridia.
Posterior quarter	6 oogonia.	0 antheridium.
Total	25 oogonia.	3 antheridia plus 2 ?

Two other sexual coenobia on the same slide have the following characters:

Specimen 20.—215 by 220 μ. Somatic protoplasts, 5 μ; cells, 8.5 μ; number, 2,360. Oogonia, 29; about 28.5 μ; absent in anterior quarter, and leaving open spaces on the near and far sides of the coenobium.

Specimen 21.—200 by 210 μ. Somatic cells, about 7.1 μ; number, about 2,960. Oogonia, 11; 25 μ; oospores, 8; 30 μ; smaller reproductive cells, 3; 14 to 18 μ; remains of sperm masses (?), 3. Reproductive cells absent from the anterior third of the coenobium.

An asexual mother coenobium (specimen 22) containing both asexual and sexual daughters is shown on Plate II, fig. 10, a micrograph taken on June 18, 1919, from a third slide (No. 6) of the same lot. Specimens such as this serve to establish the fact that asexual and sexual coenobia, such as have been described in the foregoing paragraphs, occur in the same species. This evidence is not superfluous, for on the slides of this lot

there is a small percentage of specimens of three other species of Volvocaceae, including some of *Volvox africanus* West, a species of similar dimensions. The mother coenobium of specimen 22 (Plate II, fig. 10) measures 230 by 270 μ, and has somatic protoplasts of about 5 μ diameter and cell diameters of about 9 μ, the number of cells being about 2,640. The asexual daughter measures 95 by 105 μ and contains seven gonidia. Of these the smallest is 16 by 18 μ, and the largest, 43 by 45 μ. There are six sexual daughters. Of these the smaller near one (in the left side of the picture just above the middle) contains twenty-seven reproductive cells, of which eight are small and medium-sized, 11 to 12 μ, and nineteen are large, about 17 μ. The larger near daughter (in the lower side of the figure) contains about twenty-nine reproductive cells of 15 to 18 μ. The other daughter with reproductive cells in plain view (the lower one on the left side of the photograph) contains about thirty-one reproductive cells of 15 and 18 μ, mostly of the larger size. The three other sexual daughters have about the same number of reproductive cells, and all of the sexual daughters are elongated and free from reproductive cells in one end. A number of endophytic algae are prominent in the walls of the mother coenobium.

Several other examples of mother coenobia, containing mixed broods of progeny differing in no significant particular from the one just described were found on the slides of the lot under consideration.

A sexual coenobium with a smaller number of reproductive cells occurs as a daughter in the mother coenobium shown in Plate II, fig. 11. This specimen (No. 23) is on one slide (No. 1) of a lot prepared from the same material as the type slide, but with the omission of the nigrosin stain. The mother coenobium measured, when the micrograph was taken in June, 1919, 170 by 210 μ. The somatic protoplasts were then about 5 μ in diameter and the average cell width about 7.1 μ. The estimated number of cells is 2,420. The mother contains one gonidium, 52 by 53 μ, four asexual embryos, and one sexual embryo. The most advanced asexual embryo is not much beyond the bullet stage. This embryo is elongate, 57 by 75 μ, almost pointed at the anterior end and blunt at the opposite end. It contains eight gonidia of about 18 μ diameter. Four of these are closely grouped against the posterior wall of the coenobium, three lie almost a gonidial cell diameter in advance of the posterior quartet, and one is almost two diameters ahead of the quartet. Beneath this embryo there lies one in the typical bullet stage,

side view, with the gonidia too closely packed to be counted. The two other asexual embryos are still less advanced, but with the entry of the gonidia accomplished. The sexual embryo, the presence of which is the reason for the description of its sisters and mother, is nearer the posterior pole and more advanced in development than any of its sisters. It retains the bullet form, with a sharper and blunter end, and measures 60 by 82 μ. The average cell diameter is about 3.6 μ, and the estimated number of cells is 1,250. The reproductive cells are sixteen in number and about 12 and 14 μ in diameter. They are arranged in four alternating and intermeshing quartets, distributed in about three-fourths of the length of the coenobial cavity, the anterior quartet being more separated from its neighbors than are the others.

Another sexual coenobium (specimen 24) with a small number of reproductive cells is shown in Plate II, fig. 12. It is on another slide (No. 12) of the same lot as the type slide. It measures 160 by 170 μ. The somatic protoplasts are about 5 μ wide, and the somatic cells about 8.3. The number of cells is estimated at 1,400. The reproductive cells are fifteen in number. Thirteen of them are oogonia of about 28 μ, and two, near the posterior pole, are oospores of about 32 μ, with the walls as yet only slightly developed. There is an absence of reproductive cells in the anterior quarter of the coenobium.

Material containing a larger proportion of sexual coenobia was collected in a shallower neighboring pond, F, within a stone's throw of pond J. A lot collected about 4 o'clock in the afternoon, September 22, 1915, was fixed in the laboratory at 8 in the morning on the following day. A batch of these, stained with Bismarck brown, saturated with Venetian turpentine, was mounted in abundance on four slides and sparingly on three others. In June, 1919, I looked at all of the specimens on slide 1 of this lot, and at about 4 per cent of the area of each of the other mounts. These slides show not only a greater abundance of sexual coenobia of *Campbellosphaera obversa*, but also a larger proportion of other Volvocaceae, including *Volvox africanus* West, the latter being represented by sexual as well as by asexual specimens. The asexual specimens of these two species are readily distinguishable, but the free female coenobia of *V. africanus* are very similar to the sexual coenobia of *C. obversa* in these preparations.

In this material many asexual coenobia were found containing asexual and sexual daughters in different numerical combina-

tions. In many of the sexual daughters sperm platelets are present in the unborn daughters. In no case were antheridial coenobia seen in the mother coenobia of this species, though they are common in the *V. africanus* coenobia mixed with them. The staining of this material does not fit it for making photomicrographs with distinct detail. For this reason I present without illustration the descriptive data pertaining to two selected specimens:

Specimen 25.—Mother coenobium, 250 by 275 μ. Estimate of somatic cells, 2,850. Daughters, 7; three asexual in a forward group and four sexual in two pairs in the posterior half of the mother. Each asexual daughter contains eight gonidia, of which the diameters range from 18 to 21 μ, 18 to 21 μ, and 19 to 25 μ. The youngest asexual daughter measures 70 by 75 μ, and the eldest, 90 by 95 μ. The latter has an average somatic cell width of 3.7 μ and an estimated number of somatic cells of 2,190. One of the sexual daughters measures 95 by 110 μ and has an average somatic cell width of 7.5 μ and an estimated number of somatic cells of 645. It contains eight oogonia of about 19 μ and eight antheridia. The latter are sperm platelets more or less dished. Another sexual daughter contains twelve oogonia and four antheridia, one of the latter being hemispherically cup-shaped. A measurement of 23 μ across the mouth of the cup, with about 1.8 μ for the spacing of the sperms, gives an estimate of more than two hundred fifty-six for the number of sperms in this antheridium. The next daughter contains sixteen oogonia and no antheridia, and the last one fifteen oogonia and one antheridium.

A number of gonidia, or gonidial products, greater than eight was noticed in only one specimen that could be certainly identified as belonging to this species.[2] It is on the same slide as the preceding. The generic characters presented by the embryos render its identity unmistakable. A description of it follows:

Specimen 26.—Coenobium, 210 by 220 μ. Somatic cell width, 8 μ. Number of cells, 2,570. Contents, 4 gonidia and 5 embryos. The gonidia lie near the coenobial equator, in advance of it, and measure 44, 50, 50, and 54 μ. The embryos are grouped in the hinder part of the mother. Four are in the closing bowl stage and one, the hindmost, is in the bullet stage.

The extent of the cell membranes around the gonidia and the embryos produced from them is not easily discernible, even in much of the material which has been stained with Bismarck brown. Although the inner limit usually becomes visible as

[2] The only other specimen containing more than eight gonidia on this slide is one with dimensions 190 by 205 μ; average cell width, 4.2 μ; number of cells, 7,800; and nine gonidia, all of which measure about 40 μ, except one near the posterior pole, which is 36 μ. This is probably a specimen of *Volvox carteri* Stein (*V. weismannia* Powers).

soon as the membrane ceases to conform with the segmentation products of the protoplast, the outer limit is visible only in cases of more or less deeply stained material. Examples of such are found on slides bearing material stained with Bismarck brown alone (Nos. 1 and 3). In the shrunken, Venetian turpentine preparations each gonidium is surrounded by a membrane which has almost no thickness on the outer side, but reaches to the center of the coenobium on the inner side, grading from one side to the other in such a way that the cavity of the coenobium is filled with the substance of these walls, except for very small interstitial spaces where three of the walls meet, and a large space in the anterior quarter of the coenobium. The very thin outer part of the gonidium wall has an extent of about a fourth or fifth of the circumference of the gonidium, and a corresponding superficial area of the gonidial protoplast is in close relationship with neighboring somatic cells. A large proportion of the shrinkage that occurs in the Venetian turpentine specimens takes place in the gelatinous matrix, if there be such, which fills the coenobial cavity.

The natural form of the membranes of the gonidial cells is best shown by specimens near the margins of the cover glasses of the type slide and others of the same and sister lots of Venetian turpentine preparations. The marginal and submarginal specimens on these slides are swollen instead of shrunken like those which make up the bulk of the preparation. This is true under about the marginal millimeter of the 24 millimeter square covers. The specimens here are beautifully plump. In fact many of them seem to be excessively turgid. The swelling involves only the cell membranes and not the protoplasts. It is most marked at the edge of the cover and in a space the greater part of a millimeter in width. Then, in a narrower zone, the specimens grade off from terete to shrunken. The marginal specimens are also faded. The Bismarck brown is here more rapidly and completely faded than the nigrosin stain, in both the single- and double-stained material. The most beautiful of the specimens are the coenobia in which full expansion of the cell walls has been accompanied by a certain degree of bleaching. In some of these, careful focusing reveals the gonidial membranes. In a coenobium with well-developed gonidia it can be seen that over an area on the outer side of the gonidium its membrane is very thin, as noted in the shrunken specimens, and that on the inner side it is very thick—thicker than in the shrunken specimens—so thick as almost to fill the central cavity of the coenobium and

to form planes of contact with the walls of opposite and neighboring gonidia. The thickening of the inner wall of the gonidium, sufficient for contact with the walls of the neighbors, extends outward to about the equatorial plane of the gonidial protoplast. From this region outward the walls separate and rapidly shade off in thickness, leaving an intercellular space between the gonidial walls and the walls of the somatic layer. The anterior walls of the anterior quartet of gonidia round out into the anterior intercellular space of the coenobium.

The terete condition of the coenobia under the margins of the cover glasses seems to be due to the absorption of atmospheric moisture during the storage of the preparations. The first water absorbed seems to be taken up by the cell membranes, particularly by the intralamellar substance of the somatic and gonidial cell walls, and by the substance in the intercellular coenobial cavity. After sufficient water has been absorbed for the complete expansion of the cell walls, additional water absorbed seems to be taken up by the protoplasm and by salts in the vacuoles, rendering the specimens unsightly.

The form and extent of the membranes of the sexual reproductive cells I have not been able to determine.

The details of the structure of the somatic protoplasts as they occur in the living and the fixed material are yet to be studied, and will not be taken up here.

The full history of the segmentation of the gonidia and the metamorphosis of the embryos will likewise be left for future study. The material on the type slide was purposely fixed at an hour when the characteristic stages of the embryos were present in abundance, with the result that stages of segmentation of the gonidia are lacking in this batch of material.

The most distinctly peculiar features of the ontogeny of this species appear in Plate II, figs. 13 and 15. These are both from slide 1 of the pond F material. Fig. 13 shows a specimen (No. 27) in which the youngest of seven embryos, in the left upper quarter, is in the bowl stage with the gonidia perched on the rim of the bowl. The older embryos are in the bullet stage, the four in the center and the right upper quarter presenting side views, and the two lower ones presenting almost rear polar views. In all of these bullet embryos, except the nearer one showing a side view, the gonidia are closely packed, and in the exceptional case they have begun to separate.

The bullet embryos are shown on a larger scale in Plate II, fig. 15, a view of a specimen (28) containing six embryos and one

gonidium. These embryos are all in the same stage. The same specimen is shown in fig. 16 on a smaller scale for comparison with fig. 17.

The separation of the gonidia in the daughters is shown in Plate II, fig. 17, a mother coenobium (specimen 29) containing six daughters and one gonidium. In all of the daughters the gonidia have become separated, and they can be counted by focusing the microscope. The number in each case is eight. In this stage the species is not easily distinguishable from *Volvox carteri* Stein.

The variation and graduation in size of the gonidia in the same coenobium, and the consequent gradation in advancement of sister embryos, may be practically lacking, as shown by figs. 15 and 17 of Plate II. On the other hand, a multitude of specimens can be found with a gradation as pronounced, and an arrangement as symmetrical, as is shown in Plate II, fig. 14, which shows an asexual specimen (No. 30), containing six gonidia arranged in three alternating pairs. This is from slide 1 of the pond J material.

The number of somatic cells estimated to occur in the specimens described, together with the number of reproductive cells counted in each case, are given in Table I.

TABLE I.—*Number of cells in Campbellosphaera obversa.*

Asexual coenobia.			Sexual coenobia.		
Specimen No.	Somatic cells.	Reproductive cells.	Specimen No.	Somatic cells.	Reproductive cells.
12	3,520	6	21	2,960	22
1	3,470	7	18	2,660	17
11	3,080	7	19	8,460	28
25	2,850	7	20	2,360	29
Type	2,830	7	17	2,330	23
10	2,675	7	14	2,300	28
22	2,640	7	13	2,200	23
2	2,635	8	16	1,920	23
26	2,570	9			
3	2,520	8			
4	2,425	6			
23	2,420	6	24	1,400	15
6	2,370	6	23[a] Daughter	1,250	16
7	2,370	6			
5	2,280	6			
25[a] Daughter	2,190	8	25[b] Daughter	645	16

The foregoing descriptions form the basis for the following:

DIAGNOSIS OF GENUS AND SPECIES

CAMPBELLOSPHAERA genus novum

(*Volvocaceae, Volvoceae*)

Body a spherical or spheroidal coenobium of biciliate cells which contain chloroplasts. The cells appear to lie in the periphery of a gelatinous matrix surrounded by a hyaline envelope through which the cilia extend. Somatic protoplasts globose or ovoid, each enclosed in a thick gelatinous membrane which is prismatic in form with truncate interior end and more or less rounded exterior end. No protoplasmic filaments connecting the protoplasts. Asexual reproduction by gonidia, differentiated in early embryonic stages, which migrate from without into the interior of the embryo through the phialopore before closure. The gonidia are distributed and held in place by their thickened gelatinous walls. They develop to relatively large size before segmentation. Sexual reproduction by oospores which are more numerous and smaller than the gonidia, and are usually formed in the same coenobia with antheridia. Antheridia less numerous than the oogonia, in the form of platelets. Spermatozoids elongate, probably with terminal cilia.

CAMPBELLOSPHAERA OBVERSA sp. nov.

Coenobium spheroidal or more or less elongate; dimensions commonly less than 500 μ. Number of somatic cells mostly between 2,000 and 3,000; protoplasts globose, about 5 μ in diameter; cell membranes very convex on the outer side. Gonidia, usually 8, 7, or 6, sometimes fewer, seldom more, arranged in quartets, or pairs, or a quartet and one or two pairs, in graded sizes arranged symmetrically with respect to the polar axis of the coenobium; those of the posterior pair or quartet the largest and segmenting first, those of the anterior pair or quartet smallest and segmenting last. Gonidia, 15 to 18 μ in diameter when differentiated, attaining diameters of 50 to 90 μ before dividing. Daughter coenobia developing their gonidia to large size before birth. All daughters born through one hole formed by loss of somatic cells in a circular area about the posterior pole. Asexual and sexual daughters formed in the same mother coenobia. Sexual coenobia monoecious. Gametangia more numerous and smaller than the gonidia, largest number, about 30; diameters, about 12 to 14 μ when first differentiated, becoming about 29 to 37 μ in diameter; the smaller becoming antheridial platelets of 128 sperms, the larger more numerous and becoming oogonia.

Outer wall of oospore reticulately wrinkled or ridged, diameter, about 34 to 42 μ. Spermatozoids, about 6 μ long.

Habitat.—Fresh-water ponds, near Manila, Philippine Islands.

COMPARISON WITH PREVIOUSLY DESCRIBED SPECIES

The earliest described *Volvox* with megalogonidia similar to those of *Campbellosphaera* is *Volvox carteri* Stein ('78), which was described by Carter from Bombay, India, in 1859, under the name *Volvox globator*. Carter's description presented the large gonidia, one of which is shown in his fig. 4. That these gonidia must be differentiated early in the ontogeny is evident from the size which they reach before birth as shown in his fig. 1. Points of difference from *Campbellosphaera* appear in this figure; namely, the globose form of the coenobia, and the practically uniform size of the gonidia in each daughter. This uniformity is further shown in his fig. 3, in which the gonidia have reached the maximum size before segmentation. Carter represented his species as having somatic cells with globose or ovoid protoplasts, in which respect it is like our new genus.

A variety of *Volvox carteri* was described by Powers ('08), from Missouri, under the name *Volvox weismannia*. Powers failed to perceive that what Carter, in referring to his fig. 4, called a "daughter" was in reality a gonidium and identical with one of the reproductive cells which Powers called "primary sex cells" and "ova." Powers did, however, clearly recognize and emphasize the fact that these reproductive cells are differentiated at an early stage in the development of the embryo. The semi-diagrammatic nature of Carter's drawings masked the symmetry of the arrangement of the gonidia in the coenobia, which Powers noted as characteristic of his species. Powers supplied enough information on the embryos to show that the species lacks a migration of the gonidia such as is characteristic of *Campbellosphaera*. He showed clearly that his species also forms "dwarf male" coenobia, a point of difference from *C. obversa*. He overlooked the distinction between asexual and female coenobia, though he figured embryos of both kinds [Powers ('08), Plate 26, fig. 45 asexual, and fig. 47 female].

In my own collections, made in the neighborhood of Manila, on many of the eight hundred thirty-four slides of *Volvox* in my cabinets, and among the one hundred fifty photomicrographs of *Volvox* that I made in 1916, there is a multitude of forms and stages of *Volvox carteri*, which promises to afford material

for a more complete account of the species than has yet been published.

Another species with megalogonidia and other characters similar to those of *Campbellosphaera* was described by West ('10) from Albert Nyanza under the name *Volvox africanus*. This species also has the gonidia differentiated at an early embryonic stage. The original account of this species is sufficiently complete to mark it as entirely distinct from *Campbellosphaera*, though in form and size of the coenobia it approximates the characters of the latter.

Several varieties of *Volvox africanus* are abundant in my Philippine material, which should serve as a basis for a more complete account of this species also.[3]

A species of *Volvox* found by Meyer ('96) in Germany, and called by him *V. tertius*, resembles *Campbellosphaera* in having large gonidia, which are probably differentiated early, and in having round somatic protoplasts without protoplasmic connections. Meyer's text figure 7 would serve as well for a diagram of a radial section through the somatic cells of *Campbellosphaera obversa* if the outer peripheral membrane, or cuticle, *p*, were absent, leaving the intercellular spaces, *o*, continuous with the surrounding space. *Volvox tertius* appears to be more nearly related to *Campbellosphaera* than to the older species of *Volvox*. It is unquestionably distinct from both *V. globator* Ehrenberg and *V. aureus* Ehrenberg. Still there is lack of a sufficiently complete description to enable us satisfactorily to assign it to its place among its kindred.

Some specimens, collected and prepared by Doctor Migula, of Karlsruhe, were described and figured by Klein ('89B) under the name *V. aureus*, which I believe to have been an incorrect use of the name. Six of the eight coenobia figured (Plate 3, figs. 1 to 3 and 6 to 8) show daughters containing gonidia, gynogonidia, and androgonidia, all so large as to indicate plainly that the specimens belong to a megalogonidiate species. It is, therefore, questionable whether the cells that Klein called fertilized eggs ("kürzlich befruchtete Eier") were really such and

[3] At the present time, June, 1919, the manuscript is partially prepared of a paper describing at length *Volvox carteri* and *V. africanus* and proposing for them a new genus to be known as *Merrillosphaera*. The leading species of this genus will then be; *Merrillosphaera carteri* (Stein) Shaw (synonyms: *Volvox globator* Carter non Ehrenberg, *V. carteri* Stein, *V. weismannia* Powers) and *Merrillosphaera africana* (West) Shaw (synonym: *Volvox africanus* West).

not megalogonidia such as others have mistaken for eggs. It is even questionable whether the connecting filaments shown in Klein's fig. 7 ('89B, Plate 3) really belong there. The material is of a species more nearly akin to *V. tertius* and *V. carteri* than to *V. aureus.*

A more completely described species is another by Powers ('07 and '08), from Nebraska and other parts of North America, to which he gave the name *V. spermatosphaera.*[4] This species also has rounded somatic protoplasts without protoplasmic connections, and the number of the cells has a range like that of *Campbellosphaera.* But the dimensions of the coenobia run to much larger sizes, the cells being farther apart. The gonidia, or primary sex cells, are of considerable size in the daughters at the time of birth, though not so large as to indicate their differentiation at such an early period as is characteristic of *Campbellosphaera* and the kindred megalogonidiate Volvoceae. The species is characterized by having male coenobia of which all the cells become antheridia (sperm platelets), leaving no somatic cells.

In my Philippine material there is still another species, apparently most nearly related to *V. spermatosphaera,* awaiting its turn to be described.[5] It is like the foregoing species in many respects, except that the gonidia are smaller at birth, and the antheridia are relatively fewer and formed in the same coenobia as the oogonia.

A recent addition to the free-celled larger Volvoceae is one described by Powers ('07) from material obtained in Nebraska, and named by Shaw ('16) who proposed it as the type of a new genus under the name of *Besseyosphaera powersi.* This species is more like a *Pleodorina* Shaw ('94) than like a *Volvox,* the gonidia not being differentiated in the daughters until after birth of the coenobia in which they are formed. The life history of *Pleodorina californica* has been rounded out by Chatton ('11) from the study of material collected in France. A step farther down the scale is the species *P. illinoisensis* Kofoid ('98), the simplest of the Volvoceae which have differentiation of reproductive from somatic cells. The life history of this species has been given in detail by Merton ('08) from material obtained in Germany.

[4] Originally spelled "*spermatosphara,*" and emended by West ('16).

[5] The manuscript of the description of this species is partially prepared and the species assigned to be the type of a proposed new genus under the name *Copelandosphaera dissipatrix* Shaw.

The earliest described and well-established European species of *Volvox, V. globator* Ehrenberg ('38) and *V. aureus* Ehrenberg ('38), were described at length by Cohn ('75), whose colored plate of *V. globator* has long been a classic for textbook and handbook illustration, and by Klein ('89A and '90), who made the largest contribution to the stock of pictures of *V. aureus* in various stages and phases. His figures include at least one, ('90) Plate 2, fig. 4, which is decidedly not of *V. aureus,* but of one of the megalogonidiate species. At about the same time Overton ('89) made a contribution to the knowledge of the life history of the then known European species of *Volvox.* More exact knowledge of the cell membranes of the somatic cells of the two European species was the result of the work of Meyer ('95 and '96) who incidentally gave us what information we have on his new species, *V. tertius.* His diagrammatic drawings of the cell membranes of *V. globator* and *V. aureus* are becoming classic by reproduction in handbooks. I never look at these drawings without feeling that it is improper to retain these two species in the same genus.

A species with a close affinity to *V. globator* was described by Powers ('08) from Nebraska under the name *V. perglobator.* The somatic protoplasts of this species are highly stellate and connected with their neighbors. The same is true of another species described by West ('10) from Rhodesia under the name *V. rousseleti.* In this one the cells are smaller and more numerous.

My own Philippine material[6] contains at least two species, both labeled with new names in my note books and in the albums containing their photomicrographs, which are more or less closely similar to *V. globator, V. perglobator,* and *V. rousseleti.*

In 1914 my collection of slides contained two excellent glycerin mounts of *Volvox aureus* (labeled *V. minor*) marked "4-16-96." The date indicates that the specimens were collected at Stanford University, California. They were under cover glasses sealed to the slides with Brunswick black which had cracked and become loosened. They had been fixed and stained with picro-nigrosin and the glycerin was slightly tinged with the picric acid. The staining had been very light. The specimens were mostly in beautiful condition after eighteen years under the covers, but the glycerin had partly escaped and was

[6] Some material collected in Borneo by Mary Strong Clemens contains a similar species.

still going. The appearance of the coenobia under the low powers, and the characters of the protoplasts, protoplasmic filaments and spores under the high powers, were so exactly like the excellent figures of Klein ('89A and '90) and of Overton ('89) as to engender in any one who studied the specimens with the literature a feeling that Volvoces must be about the same all over the world, and that both of the existing species have been well described. It was evident that the specimens would need remounting. Before demounting them, I took some notes and measurements—and fortunately, for the specimens after being remounted are not what they used to be.

The most recent advance in our knowledge of *Volvox* has come from the studies of Janet ('12 and '14) in France. In a long paper he gave a monographic account of the genus in which he incorporated and extended the membrane studies of Meyer, and he followed that with a preliminary paper in which he announced the discovery that the egg apparatus of *Volvox globator* is not a unicellular oogonium, but that it is multicellular and morphologically a dwarf coenobium. This fact will necessitate careful study of the corresponding parts of other species of *Volvox* and related genera.

There are two well-marked groups of the higher Volvoceae: (1) those *Volvox* species with protoplasts connected by protoplasmic filaments, namely, *V. aureus, V. globator, V. perglobator,* and *V. rousseleti;* and (2) those without the interprotoplastic connecting filaments, namely, *V. spermatosphaera, V. tertius, V. africanus,* and *V. carteri* (*V. weismannia*). The species of the second group are more or less megalogonidiate, and it is those of this group that are more so with which *Campbellosphaera* is more closely allied. My present conception of the relationships of the Volvoceae is represented by fig. 1.

SUMMARY

From fixed and living specimens collected near Manila, Philippine Islands, a new species of the Volvocaceae (subfamily Volvoceae), is described which I propose for the type of a new genus under the name *Campbellosphaera obversa.* A type specimen is described in detail and figured by photomicrographs. It exhibits the most peculiar character of the genus, which is migration of gonidia, formed early in the development of the embryo, from the outside to the inside of the embryo through the phialopore. The gonidia become very large before dividing. The somatic protoplasts lack protoplasmic connecting fibers.

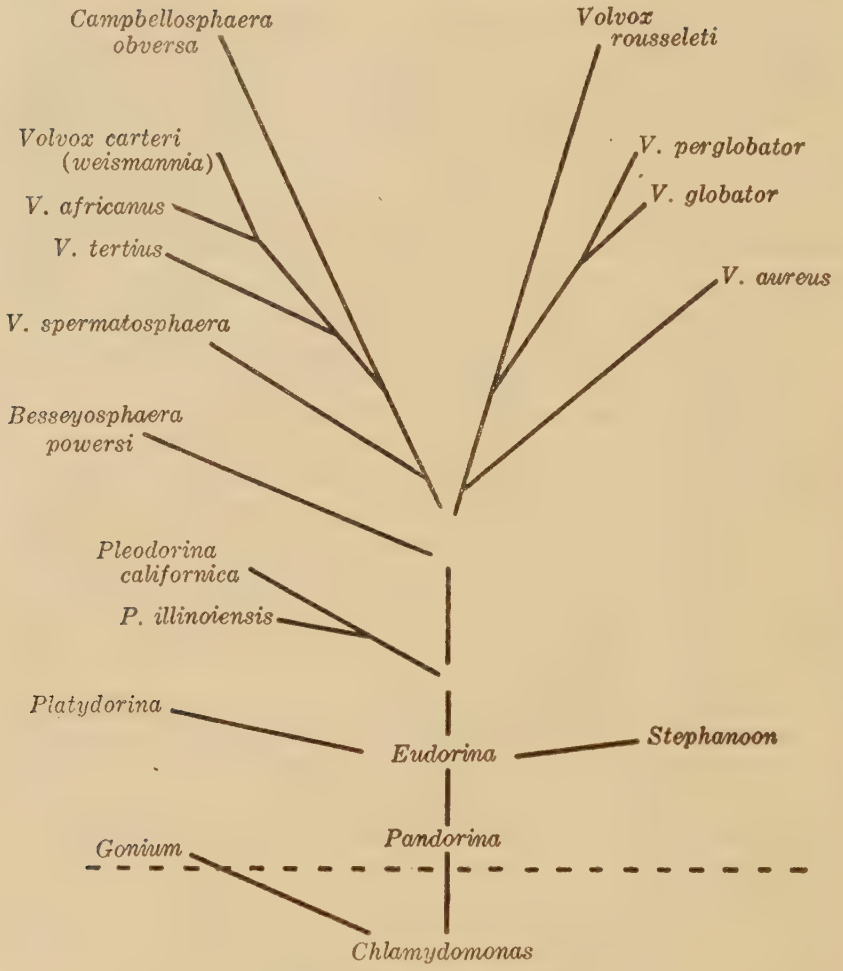

FIG. 1. Phylogeny of the Volvoceæ.

A series of specimens is described which supply the salient features of a rounded life history with asexual and sexual reproduction. Many details are left for future work and workers. The sexual coenobia are monoecious.

Formal diagnoses of the genus and species are followed by a comparison of the new genus with the recorded species of *Volvox* and closely related genera. Some existing synonomy is pointed out, reducing *V. weismannia* Powers to *V. carteri* Stein, and some future synonomy is foreshadowed.

Volvox aureus Ehrenberg is reported as having been collected in California in 1896. The specimens were found to agree closely with the ample description of the species by Klein ('89A and '90).

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ILLUSTRATIONS

[Photomicrographs of *Campbellosphaera obversa* Shaw, from specimens mounted in Venetian turpentine, taken by W. R. Shaw and E. Cortes at the Bureau of Science, Manila.]

PLATE I

FIG. 1. Type specimen containing three gonidia, two closing bowl embryos with their gonidia migrating inward, and two bullet embryos of which the gonidia form a close cluster within each closed phialopore. × 200.

2. The same specimen with less magnification and more depth of focus. × 100.

3. A coenobium containing two gonidia and five embryos with a foreign body in the background simulating an additional embryo. The lower embryo on the right side is the oldest, the upper one on the same side being the youngest. × 100.

4. A nearly mature mother coenobium containing seven asexual daughters, in each of which there are from six to eight gonidia. × 100.

5. An asexual coenobium containing four gonidia and two young embryos. × 100.

6. A nearly mature sexual coenobium between two young asexual coenobia. The sexual coenobium shows dark oogonia and lighter oospores, of which there are twenty-three in all. The asexual coenobia contain seven gonidia each. × 100.

7. A portion of the same coenobium photographed on a larger scale. It shows an oogonium, oospores, and somatic cells. A little above and to the left of the center of the figure is a young specimen of an endophytic alga occupying the angle between four somatic cells. × 400.

8. A younger sexual coenobium containing twelve oogonia and sixteen oospores. × 100.

9. A still younger sexual coenobium containing twenty-five oogonia and three antheridia. One of the latter lies near the middle of the right side and another is at the top of the same side. × about 200.

PLATE II

FIG. 10. A nearly mature asexual coenobium containing one asexual daughter with seven gonidia at the right side of the top, and six sexual daughters containing each from twenty-seven to thirty-one reproductive cells, more or less. × about 200.

11. An asexual coenobium containing, in addition to one gonidium and four asexual embryos, one sexual daughter (the lowermost embryo) with sixteen reproductive cells.

FIG. 12. A sexual coenobium between two asexual ones. The former contains fifteen reproductive cells, of which thirteen are oogonia and two are oospores. The asexual coenobium at the right contains seven gonidia; two pairs of larger ones in the posterior half of the coenobium (uppermost in the figure) and three smaller gonidia in the anterior half. The coenobium at the left contains two pairs of large gonidia in the posterior half, one smaller gonidium in the anterior half, and a still smaller anomalous cell like a gonidium at the posterior pole. × 100.

13. An asexual coenobium with seven embryos. It shows end and side views of bullet embryos, and a side view of a bowl embryo with the gonidia (8) obviously outside of the bowl. × 100.
14. An asexual coenobium with three pairs of gonidia. × 200.
15. An asexual coenobium with one gonidium and six embryos which are all in the bullet stage, the daughter gonidia being closely clustered about the posterior pole of the coenobial cavity. × 200.
16. The same coenobium in slightly different focus. × 100.
17. An asexual coenobium containing seven embryos, in each of which the gonidia have become separated. × 100.

TEXT FIGURE

FIG. 1. Phylogeny of the Volvoceae.

PLATE I. CAMPBELLOSPHAERA OBVERSA SHAW.

PLATE II. CAMPBELLOSPHAERA OBVERSA SHAW.

SOME MALAYAN DELPHACIDÆ (HOMOPTERA)

By Frederick Muir

Of the Hawaiian Sugar Planters' Experiment Station, Honolulu

ONE PLATE

This paper deals with a few of the specimens of Delphacidæ recently collected by Prof. C. F. Baker. I hope in the near future to be able to report on the remainder of the collection.

The more I study this family the more I am convinced that the tibial spur must form the chief characteristic for the primary division, although it may appear to be, at times, more artificial than natural. Any other one character is still more unsatisfactory.

The types of the new species described in this paper are deposited in the collection of the Hawaiian Sugar Planters' Experiment Station, Honolulu, H. T., and the paratypes, when present, in the Baker collection.

Genus **PUROHITA** Distant

Purohita nigripes sp. nov.

Male.—Macropterous; width of vertex at base slightly more than length, base slightly behind middle of eyes, twice width of apex; basal joint of antennæ 1.5 times the length of second.

Very light brown; apical half of face, genæ, and lateral margins of pronotum whitish, a dark brown line dividing the white lateral portion of pronotum from the rest, darker brown over abdominal tergites, a dark longitudinal mark on first and second femora, tarsi of those legs black or dark brown. Tegmina hyaline, slightly opaque, veins white with irregular black spots, a dark brown mark over cross veins, not quite reaching to inner margin and fading out toward apex; wings hyaline, slightly opaque, veins light brown.

Lateroventral edge of pygophor produced into a small, obtuse angular process; genital styles straight on inner margin and on outer margin for basal two-thirds, then tapering to the acute apex, which is curved outward.

Length, 3.5 millimeters; tegmen, 4.0.

Female.—Basal joint of antennæ slightly longer in proportion to the second (1 to 1.8); whitish mark over apical half of face and lateral margin of pronotum slightly greenish.

Length, 5.3 millimeters; tegmen, 5.7.

PENANG (*C. F. Baker, 9874*), 1 male and 1 female.

Genus BAMBUSIBATUS Muir

Bambusibatus albolineata Muir.

BORNEO, Sandakan (*Baker, 9889*), 2 females.

Genus TROPIDOCEPHALA Stål

Tropidocephala STÅL, Ofv. Vet. Ak. Forh. (1853) 266.

Tropidocephala malayana Matsumura.

Tropidocephala malayana MATSUMURA, Ann. Mus. Nat. Hung. 5 (1907), 64, pl. 2, figs. 5, 11.

PENANG, 1 male and 1 female. SINGAPORE, 1 male. (*Baker, 9851, 9852*).

The males are darker in color than the females, the apical veins and across the apical cells being fuscous. The male genitalia are very close to those of *T. dryas* (Kirk.).

Genus BRACHYCRAERA Muir

Brachycraera albolineata Muir.

BORNEO, Sandakan (*Baker*), 2 specimens.

Genus UPACHARA Distant

Upachara straminea sp. nov. Plate I, fig. 1.

Female.—Macropterous; head broader than thorax, width of vertex double the length, apex not or but very slightly produced in front of eyes and together with outer edges of eyes forming nearly a semicircle, base of vertex in front of middle of eyes, curved parallel to apex; carinæ faint, diamond cell obscure, basal cells 5-sided with a small depression in middle of each; face very little longer than broad (1 to 0.9), sides arcuate, median carina simple; antennæ small, not reaching base of clypeus, first joint about as long as wide, second joint twice the length of first. Pronotum as long as or slightly longer than vertex, faintly tricarinate, lateral carinæ strongly divergingly curved, not reaching hind margin, mesonotum faintly tricarinate. Hind tibiæ longer than tarsi, first tarsus subequal to other two together; spur not as long as first tarsus, small, cultrate, thick, a small tooth at apex but none on hind margin.

Stramineous; spines on hind legs black; tegmina hyaline, light stramineous, veins little darker; granules minute, sparse, with fine, black hairs.

Length, 2.7 millimeters; tegmen, 2.8.

PENANG (*Baker, 9862*), 1 female.

Genus SOGATOPSIS Muir

Sogatopsis pratti Muir.

BORNEO, Sandakan (*Baker*), 1 female.

Genus MALAXA Melichar

Malaxa obtusipennis sp. nov.

Female.—Macropterous; vertex longer than wide (1 to 0.8), base slightly wider than apex, diamond cell slightly before apex, apex very slightly curved, base slightly behind middle of eyes; length of face 2.7 times the width, slightly narrowed between eyes, sides straight, subparallel; antennæ reaching well beyond middle of clypeus, second joint twice the length of first. Tegmina with apex more obtuse than in the type species, but apical cells forming about one-half of tegmina.

Black, or deep, shiny, liver brown; antennæ, apex of clypeus, rostrum, legs, carinæ of vertex and pronotum, base of mesonotum and abdominal sternites light brown or yellow; ovipositor dark. Tegmina dark brown, clear hyaline at apex of clavus extending into corium, and at apex of costal cell and first two apical cells and apex of third apical cell, veins between them dark; veins dark brown; wings hyaline.

Length, 2.2 millimeters; tegmen, 2.8.

BORNEO, Sandakan (*Baker, 9894*), 3 females.

Malaxa bakeri sp. nov. Plate I, fig. 3.

Male.—Macropterous; length of vertex nearly equal to width at base (1 to 0.9), base situated considerably before middle of eyes, wider than apex, which is very slightly rounded; length of face 2.4 times width, slightly widened from base to apex, sides straight, median carina simple; antennæ reaching a little beyond base of clypeus, second joint 2.5 times the length of first; hind tibia slightly longer than tarsi, first tarsus subequal to the other two together. Tegmina long, apex subacute, apical cells forming half of tegmen (cross veins in middle of tegmen). Stramineous; slightly fuscous on pronotum between carinæ and on abdominal tergites. Tegmina hyaline, clear; longitudinal veins white; granules very minute with white hairs; cross veins

dark brown, forming a line from apex of clavus to middle of costa, broadening slightly toward costa; wings hyaline, veins white.

Pygophor very shallow, the diaphragm being nearly on a level with the rim, medioventral edge with a small spine curved to the left, anal segment with a single, large spine from the left side; genital styles narrow, long, with the apex produced into a curved, flat spine turned outward; ædeagus complex with a long curved spine on right side (not dissected out).

Length, 1.9 millimeters; tegmen, 2.6.

Female.—Macropterous; similar in coloration to the male.

Length, 2.5 millimeters; tegmen, 3.4.

LUZON, Bataan Province, Limay (*Baker, 10079*), 1 female; Laguna Province, Mount Maquiling (*Baker*), 1 female. SINGAPORE (*Baker*), 1 male. PENANG (*Baker*), 1 female.

The vertex is longer, the antennæ are shorter, and the tegmina are less acute than in the type species.

Malaxa javanensis sp. nov. Plate I, fig. 2.

Male.—Macropterous; base of vertex slightly wider than the length, considerably behind the middle of eye; length of face 2.2 times width, slightly widening toward apex, sides straight; antennæ reaching only to base of clypeus, second joint 2.4 times length of first; cross veins of tegmina at middle.

Yellow; lateral portions of pronotum, tegulæ, coxæ, and abdominal tergites dark brown. Basal half of tegmina brown, apical half hyaline, veins same color as membrane, granules very minute; wings hyaline with light brown veins.

Pygophor a little longer than broad, no spines on medioventral edge, anal segment with a large, curved spine on left side; genital styles asymmetrical at base.

Length, 1.5 millimeters; tegmen, 2.1.

JAVA, Pekalongan (*F. Muir*), 1 male.

Malaxa nigra sp. nov.

Male.—Macropterous; length of vertex slightly longer than width of base, base about middle of eyes, slightly broader than apex, which is slightly rounded; length of face 3.2 times width, slightly widened to apex, sides straight; antennæ reaching beyond middle of clypeus, second joint 2.8 times length of first; cross veins about middle of tegmina.

Head, thorax, coxæ, and abdomen very dark shiny brown or black, antennæ, legs, lower portion of genæ, carinæ of vertex, anal segment, and ventral aspect of pygofer yellowish. Teg-

mina black or very dark brown over basal half, hyaline over apical half, veins the same color as membrane, granules very small.

Pygophor slightly compressed laterally, medioventral edge with a single small spine; anal segment with a large spine from the left side; genital styles small, slightly curved, broadest at base, apex acute; ædeagus not visible externally and not dissected out.

Length, 1.5 millimeters; tegmen, 2.3.

Female.—Similar to the male.

Length, 1.7 millimeters; tegmen, 2.3.

LUZON, Bataan Province, Mount Limay (*Baker*), 1 male: Laguna Province, Mount Maquiling (*Baker*), 1 female.

Genus ARCOFACIES Muir

Arcofacies MUIR, Canad. Ent. (1915) 261, 270, 320.

Arcofacies penangensis sp. nov.

Male.—Width of vertex at base double the length, base nearly double the width, of apex; length of face 1.5 times the width, sides slightly arcuate; antennæ not reaching base of clypeus, second joint 1.5 times length of first. In lateral view the clypeus at right angle to face, apex of face projecting slightly beyond clypeus; mesonotum considerably arched. Hind femora short, not reaching beyond apex of abdomen; tibiæ longer than femora, tarsi much shorter than tibiæ, first tarsus subequal in length to other two together, spur small, about as long as first tarsus, fairly broad, thick, a tooth at apex but none on hind margin. Tegmina acutely tectiform, compressed beyond apex of abdomen, costal margin shallowly emarginate beyond apex of abdomen, apex acute.

Ochraceous buff; hind legs slightly fuscous, abdomen bright yellow with a few, small, black spots on sternites, chestnut brown over pygophor and genital styles; tegmina chestnut brown, darkest over basal third, a clearer space along middle of costa at the emargination, a dark mark at apex of each apical vein, a small one at apex of claval vein, at fork of cubitus and fork of subcosta and radius, veins the same color as membrane, with numerous small, light granules.

Pygophor round with a small opening, no distinct dorsal emargination, anal segment short, exposed, without spines, anal style large, lanceolate; genital styles slightly curved, flattened, margins subparallel, apex truncate and produced into a quadrate process on inner margin.

Length, 2.1 millimeters; tegmen, 3.6.

Female.—Tegmina lighter than in male, abdomen ochraceous with a small black spot on each sternite, ovipositor same color as pygofer.

Length, 2.8 millimeters; tegmen, 4.4.

PENANG (*Baker, 9880*), 1 male and 1 female.

Arcofacies fullawayi Muir.

SINGAPORE and PENANG (*Baker, 9863*); previously known from the Philippines and Formosa.

Arcofacies insignis sp. nov.

Female.—Macropterous; width of base of vertex about double the length, base 1.7 times width of apex, diamond-shaped cell small but distinct; length of face 2.8 times width, sides straight, parallel, carinæ of head fairly prominent; antennæ reaching well beyond middle of clypeus, second joint very little longer than first; in lateral view clypeus strongly curved, apical portion at right angle to basal portion; hind femora short, not reaching to apex of abdomen; tibiæ longer than femora and much longer than tarsi, first tarsus subequal in length to the other two together. Tegmen similar in outline to that of type species.

Orange buff; slightly fuscous between carinæ of face and genæ, first antennal joint with two black, longitudinal marks, second joint mostly fuscous, lighter over carinæ of thorax; tibiæ with a black longitudinal line, ovipositor the same color as pygofer. Tegmina conspicuously marked with white and buff turning to light brown, some of the markings bordered with dark brown, the darker marking being over the basal two-thirds of costal cell, over basal portion of cubitus and media, marginal portion of clavus, over cross veins and spreading basad along cubitus and over apical portion of apical veins; veins light with light granules, most numerous on apical veins where they are irregular; wings hyaline with light veins.

Length, 3.3 millimeters; tegmen, 5.1.

LUZON, Mountain Province, Baguio (*Baker*), 1 female. This species is so distinct that I feel no confusion can arise by describing it from a female.

Genus SOGATA Distant

Sogata DISTANT, Faun. Brit. Ind. Rhyn. 3 (1906) 471, fig. 258; MUIR, Can. Ent. 5 (1919) 8.

Sogata 4-spinosa sp. nov. Plate I, fig. 6.

Male.—Macropterous; head considerably narrower than pronotum; length of pronotum and mesonotum 1.5 times length of

head including eyes; length of vertex 1.7 times the width, carination as in *Delphacodes* Fieb., the Y carina obscure, base considerably behind middle of eyes; length of face 2.6 times the width, sides straight, slightly widened to apex; antennæ reaching slightly beyond base of clypeus, second joint 2.2 times length of first; first hind tarsus slightly longer than the other two together, tibial spur laminate with many small teeth on hind margin; lateral carinæ of pronotum straight, diverging posteriorly, reaching hind margin.

Light ochraceous, face between carinæ fuscous, nota laterad of outer carinæ darker; pleura, coxæ, and abdomen dark. Tegmina hyaline, inner half from base of clavus to apex of tegmen light brown, darker over area apical of cross veins, veins ochraceous with many fine granules bearing black hairs; wings hyaline, veins brown.

Opening of pygophor about as long as broad, dorsal emargination large, anal angles not produced; anal segment with two pairs of spines; outer pair short, broad, and slightly curved and wide apart at base; inner pair touching at base, long, narrow, and more basad than the outer pair; genital styles short, inner edge slightly concave, apex truncate with each angle slightly produced; ædeagus figured from left side with anal segment and pygofer.

Length, 1.7 millimeters; tegmen, 2.

SINGAPORE (*Baker*), 1 male. Described from one male. It is possible that this is the male of *S. dohertyi* Dist., but it differs enough to separate it. It is interesting in possessing two pairs of spines on the anal segment.

Genus EUMETOPINA Breddin

Eumetopina BREDDIN, Deut. Ent. Zeit. (1896) 109.

Eumetopina maculata sp. nov. Plate I, fig. 7.

Male.—Macropterous; vertex slightly wider than long, base slightly wider than apex and situated slightly in front of middle of eye, apex rounded; length of face 1.3 times the width, slightly narrowed between eyes; antennæ reaching to near middle of clypeus, second joint three times length of first.

Ochraceous yellow, a fuscous mark on each side of median carina of pronotum, slightly fuscous over median portion of mesonotum, and a dark mark on each side just laterad of lateral carinæ; abdomen fuscous over tergites. Tegmina hyaline, very slightly ochraceous, veins darker, granules near together, minute, bearing light hairs; wings slightly ochraceous.

Pygophor with two minute spines close together on medioventral edge; anal segment with a single, median spine; genital styles small, narrow, slightly curved at apex; ædeagus with two spines on left side, the apical one larger and flat, the other furcate at apex, a large spine on right side at apex.

Length, 2.8 millimeters; tegmen, 3.

MINDANAO, Davao (*Baker, 10060*).

Female.—There are two specimens which I associate with the above male; namely, one from Imugan, Nueva Vizcaya, Luzon (the allotype), and one from Mount Limay, Luzon (*Baker, 9848*). They both have the pair of black marks on the mesonotum; otherwise they are ochraceous yellow.

This species is similar to *E. bakeri,* but the ædeagus is quite distinct.

Eumetopina flava sp. nov. Plate I, figs. 5*a, b.*

Male.—Macropterous; vertex about as long as broad at base, slightly narrowed to apex, which is slightly rounded; first joint of antennæ about half length of second; hind tarsi equal in length to hind tibiæ, first tarsus considerably longer than the other two together.

Light yellow; tegmina hyaline, very pale yellow, veins slightly darker, granules very minute, bearing light hairs.

Pygophor opening about as long as broad, a minute process on medioventral edge; anal segment with a single, median, curved spine on ventral edge; genital styles small, narrow, curved slightly at apex, which is pointed.

Length, 2.4 millimeters; tegmen, 3.

LUZON, Laguna Province, Mount Maquiling (*Baker, 9858*), 1 male.

Eumetopina bakeri sp. nov. Plate I, figs. 4*a, b.*

Male.—In build similar to *E. flava.* Light yellow, black over the middle portion of pronotum, mesonotum, and on metanotum and abdominal tergites.

Opening of pygophor about as deep as wide, two small processes on the medioventral edge; genital styles small, narrow, slightly curved at tip; ædeagus figured.

Length, 2.7 millimeters; tegmen, 3.

Female.—The female that I associate with this is all yellow like *E. flava.*

Length, 3.4 millimeters; tegmen, 3.6.

BORNEO, Sandakan (*Baker, 9892*).

Genus **PEREGRINUS** Kirkaldy

Peregrinus maidis (Ashmead).

BORNEO, Sandakan (*Baker*), 1 specimen.

Genus **DICRANOTROPIS** Fieber

Dicranotropis pseudomaides (Kirkaldy).

PENANG (*Baker*), 1 specimen. Previously known from Queensland.

Genus **STENOCRANUS** Fieber

Stenocranus (?) singaporensis sp. nov. Plate I, fig. 8.

This species is congeneric with, and closely allied to, *S.* (?) *taiwanensis*.[1] For the present I place these two species in *Stenocranus* while recognizing that they will eventually have to be moved.

Male.—Macropterous; Mikado orange; tegulæ, middle of dorsum of abdomen and genital styles black.

Anal segment large, projecting considerably beyond pygofer, apex broadly rounded, pygofer very shallow, styles standing well out, a small spine on medioventral line. The apex of the genital styles differs considerably from *S. taiwanensis*. In the figure the right is shown more foreshortened than the left.

Length, 1.8 millimeters; tegmen, 2.3.

Female.—Macropterous. Similar to male in coloration.

Length, 2.3 millimeters; tegmen, 2.8.

SINGAPORE (*Baker*), 1 male and 1 female (type). PENANG (*Baker, 9865, 9867, 9868*), 1 male and 4 females. Some of the females do not have the tegulæ black.

[1] Proc. Hawaiian Ent. Soc. III 4: 323, pl. 6, fig. 44.

ILLUSTRATIONS

Plate I

Fig. 1. *Upachara straminea* sp. nov., head, pronotum, and mesonotum, dorsal view.
2. *Malaxa javanensis* sp. nov., pygophor, full view.
3. *Malaxa bakeri* sp. nov., pygophor, full view.
4. *Eumetopina bakeri* sp. nov., ædeagus, *a*, lateral view, *b*, dorsal view.
5. *Eumetopina flava* sp. nov., ædeagus, *a*, lateral view; *b*, dorsal view.
6. *Sogata 4-spinosa* sp. nov., pygophor, lateral view.
7. *Eumetopina maculata* sp. nov., ædeagus, dorsal view.
8. *Stenocranus (?) singaporensis* sp. nov., pygofer, full view.

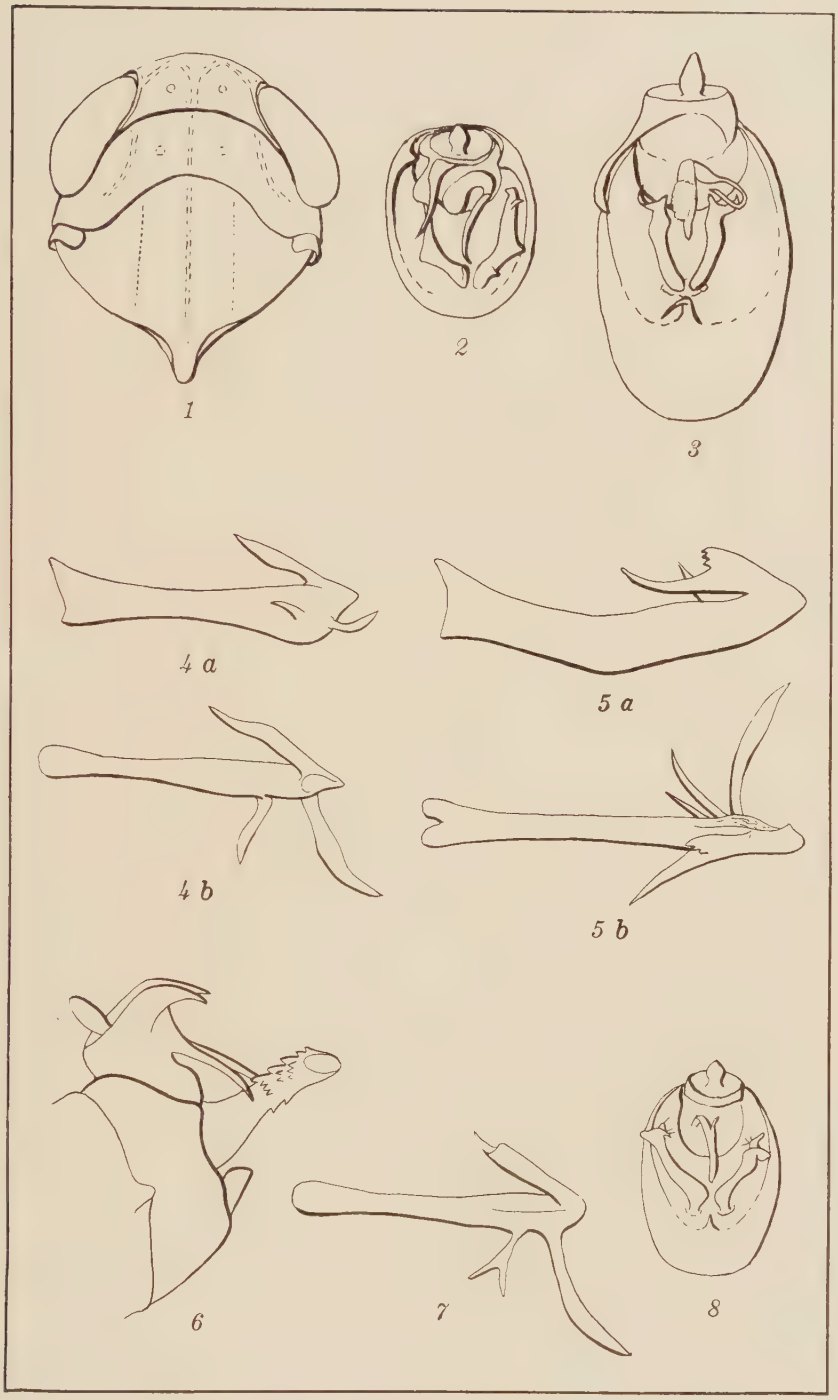

PLATE I. MALAYAN DELPHACIDÆ.

A NESTING PLACE OF MICROPUS SUBFURCATUS IN MINDORO

By Dean C. Worcester

Of Cebu, Cebu, P. I.

On May 13, 1919, having had occasion to explore the Caguray River, in Mindoro, I was resting in the shade of a great overhanging rock forming one side of the gap through which this stream finally leaves the mountains, when I noticed, only a few feet above my head, several nests of the common Asiatic barn swallow (*Hirundo javanica* Sparrman). Shortly afterward a carrier poked one of these nests down with a short stick, and from the resulting débris took two small birds, which on examination I found, to my surprise, to be young swifts. A moment afterward I saw a large, white-rumped swift enter the opening in the rock from which this nest had been removed. This bird flew away in a moment, but continued to return at frequent intervals, apparently puzzled by the loss of its young.

A more careful inspection of the underside of this overhanging rock showed, at a considerable distance above the ground, a series of grayish-colored nests, which blended so well with the rock that I had not previously noticed them. They gave the impression of being somewhat bottle-shaped, with the necks of the bottles usually directed inward toward the sloping face of the rock, the openings for entrance and egress being at the ends of the necks. In some instances there were merely round openings in the sides of the nests, and in two cases the nests were in holes in the rock, with their round openings directed outward.

By means of a long bamboo pole I succeeded in dislodging several nests. I found them to be composed almost exclusively of feathers, with which were intermingled a very limited number of bamboo leaves, a few other small leaves, and a very few blades of grass, the feathers having evidently belonged to a

great variety of wild birds. The nest materials were stuck together by the salivary-gland secretion of the birds, the cementing substance being plainly visible on the comparatively rough interior of the nest, but not in evidence on its outer side. The feathers were laid with their quill ends inward, their soft ends in many cases extending freely from the outer surface of the nest, so that the two sides of the nest presented strikingly different appearances.

Each of the nests dislodged contained two young nearly ready to fly. A specimen of an adult female sent to the Bureau of Science has been identified by Mr. R. C. McGregor as *Micropus subfurcatus* (Blyth).

A METHOD FOR LABELING SLIDES USED IN ROUTINE STOOL EXAMINATIONS

By Frank G. Haughwout

Of the Department of Parasitology, University of the Philippines

ONE TEXT FIGURE

When large numbers of stools are examined, either in the course of routine clinical laboratory work or in research, the problem of numbering the slides used sometimes presents difficulties that may lead to confusion in recording the results. Various workers are accustomed to identify their slides by attaching to one end an ordinary gummed label, by etching the number or symbol on the glass with hydroflouric acid, by scratching it in with a diamond pencil, or by writing on it with a wax pencil. All these methods are troublesome in one way or another. Pasted labels are apt to absorb moisture and come off in the solutions, or they may become so discolored from the staining solutions that the figures become undecipherable; hydroflouric acid and the diamond pencil make a permanent record on the slide which may lead to confusion in another or the same series; figures written with a wax pencil are not always legible, they frequently come off in the solutions and, in a tropical laboratory where the temperature is constantly high, the lightest touch with the fingers transforms the record into a smudge.

No originality is claimed for the method which is here described. It is so simple and practical that it is difficult to believe that no other worker has thought of and applied it. Its essential feature is the ordinary wire paper clip (fig. 1, *a*) used to hold sheets of paper together, and which may be purchased of almost any stationer. The record is made on paper labels measuring 2.5 by 2.5 centimeters.

One end of the paper clip is slightly bent as shown in fig. 1, *b*, so that it will slip easily over the edge of the slide and yet hold the paper label firmly. A stock of clips with bent ends may be kept on the work table.

In operation the number or symbol is written with a lead pencil near the lower margin of the label which is then folded at the middle, hung over the end of the slide, and secured with the paper clip as shown in fig. 1, *c*. By this procedure about 1 centimeter of the label is exposed and the characters may be

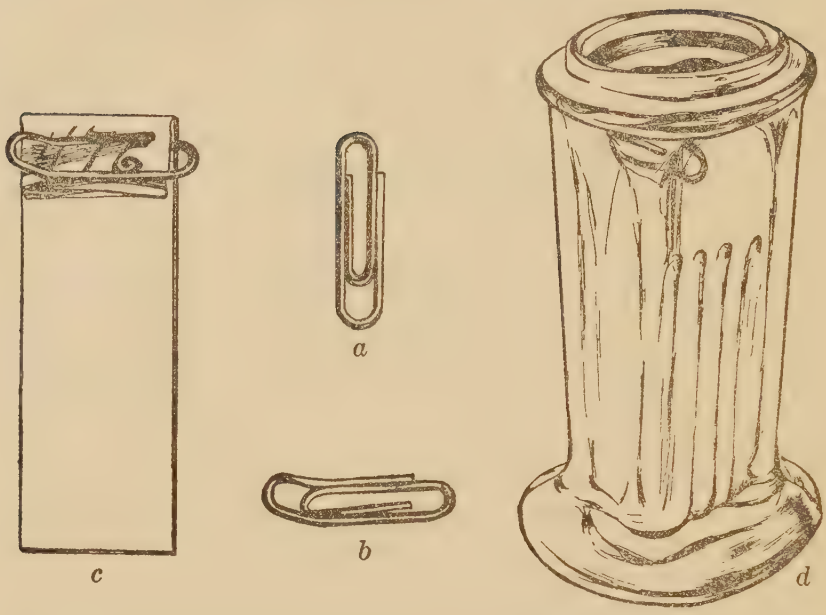

FIG. 1. *a*, paper clip as ordinarily employed; *b*, paper clip with one end bent over so it will pass easily over the surface of the slide; *c*, illustrating the method of applying the label to the slide; *d*, labeled slides in Coplin's staining jar.

easily read through the loop of the clip. The slides may then be stacked in the Coplin's staining jars, as illustrated in fig. 1, *d*, and manipulated in the usual manner. The margin of paper folded over the edge of the slide is so narrow that it will not become stained in the solutions and the slides may be washed in running water without risk of losing the labels. Slight pressure with the laboratory towel will remove any drops of water that may adhere to the clip and label after such an operation. When treatment of the preparation is completed, the clip may be detached, the paper torn across the sharp margin of the slide and the numbered end permanently attached to the slide with gum or paste. When the preparation is finally discarded the label comes off in the cleaning process and the slide is left without blemish. The clips do not interfere either with the proper stacking of the slides in the grooves of the staining jar or with the placing of the cover.

I have employed this method in making hundreds of preparations by the usual "wet" methods and have, so far, found no drawbacks to it. The clips are so cheap that when they become rusty, as they do in the course of time, they may be thrown away without any qualms of conscience.

In conclusion I desire to express my thanks to Miss Antonina Haughwout who drew the figures that accompany this note.

ILLUSTRATION

TEXT FIGURE

FIG. 1. *a*, paper clip as ordinarily employed; *b*, paper clip with one end bent over so it will pass easily over the surface of the slide; *c*, illustrating the method of applying the label to the slide; *d*, labeled slides in Coplin's staining jar.

ADDITIONS TO THE FLORA OF GUAM

By E. D. MERRILL

Botanist, Bureau of Science

In 1914 I published an enumeration of the plants of Guam[1] in which about five hundred fifty species are included. Since that paper was published some additional collections have been made in Guam by Mr. Peter Nelson, of the Guam Experiment Station, and in the early part of 1918 a grant of 50 dollars was made to him from the income of the Robinson Memorial Fund of the New York Botanical Garden for the purpose of assisting him in the prosecution of field work in Guam. The arrangements under which this grant was made were that the material collected should be submitted to me for identification; one set to be retained for the herbarium of the Bureau of Science; one set to be returned to the Guam Experiment Station; and the remaining duplicate material to be transmitted to the New York Botanical Garden for distribution by that institution.

Shortly after the field work was commenced by Mr. Nelson, Guam was visited by an unusually severe typhoon, July 6, 1918, resulting in considerable damage to the equipment of the Agricultural Experiment Station there and in the destruction of the field outfit that had been provided for Mr. Nelson's botanical work, and a considerable amount of prepared botanical material. The field work was consequently delayed as several months elapsed before it was possible to replace the destroyed equipment. The collections already made have yielded several species and representatives of a few genera, new to Guam, as well as at least two undescribed species. These data have been incorporated in the present paper, together with a few changes in nomenclature.

SCHIZAEACEAE

SCHIZAEA Smith

SCHIZAEA DICHOTOMA (Linn.) Sm. in Mém. Acad. Turin 5 (1793) 422, *t. 9, f. 9.*

GUAM, *Nelson 221,* on tree trunks at Cotot, associated with *Psilotum nudum* Griseb. A widely distributed species in the Old World Tropics, the genus new to Guam.

[1] Philip. Journ. Sci. 9 (1914) Bot. 17–155.

CYATHEACEAE

CYATHEA Smith

CYATHEA HAENKEI (Presl) comb. nov.

Alsophila haenkei Presl Rel. Haenk. 1 (1825) 68.
Cyathea marianna Gaudich. Bot. Freyc. Voy. (1826) 265.

GUAM, *Nelson 538*, May, 1919, in ravines near the headwaters of a tributary to the Pago River.

The type of Presl's species was from the Marianne Islands, in all probability from Guam, while that of Gaudichaud was from Guam. Both have been reduced as synonyms of *Alsophila extensa* (Forst.) R. Br., which does not appear to me to be correct. Regarding the occurrence of this species in Guam I wrote to Mr. Nelson in September, 1914, supplying him with photographs of Philippine tree ferns, and suggested that he search for the Guam species, to which he replied that in his fourteen years residence in Guam, in which time he had visited most parts of the Island, he had never seen any tree ferns. A few specimens were located by him in May, 1919, apparently very old plants. The larger plants were about 3 m high, the trunk 15 to 20 cm in diameter below, tapering to 10 cm near the top. The species is apparently very rare and local in Guam and is probably approaching extinction.

GRAMINEAE

THUAREA Persoon

THUAREA INVOLUTA (Forst. f.) R. & S. Syst. 2 (1817) 782.

Ischaemum involutum Forst. f. Prodr. (1786) 73.
Thuarea sarmentosa Pers. Syn. 1 (1805) 110.

GUAM, Anigua, *Nelson 342*, December, 1919, along the seashore, local name *las-aga*. A common Malayan-Polynesian strand plant, but not previously recorded from Guam.

GARNOTIA Brongniart

GARNOTIA STRICTA Brongn. in Bot. Duperry's Voy. (1829) 132, *t. 21*.

GUAM, hills back of Piti, *Nelson 359, 403*, December, 1918, and February, 1919. The genus is new to Guam, the species having been originally described from Tahiti, but now, as a somewhat variable one, known to extend from India, through Malaya to Hawaii.

DIGITARIA Heister

DIGITARIA ROBINSONII sp. nov.

Species *D. pacificae* Stapf et *D. stenotaphrodi* Stapf affinis differt racemis numerosis, plerumque circiter 15, confertis, racemose dispositis.

A glabrous, erect, apparently tufted perennial grass up to 60 cm high. Leaves rather rigid, linear-lanceolate, 15 to 25 cm long, 5 to 8 mm wide, smooth, slenderly acuminate. Inflorescence exserted, composed of about 15, ascending, somewhat crowded, racemosely arranged spikes 6 to 12 cm in length, the axis of the inflorescence up to 4 cm long. Axis of the spikes about 1 mm wide, the spikelets numerous, oblong to oblong-lanceolate, about 2.5 mm long, alternate, in two rows. First glume obsolete or reduced to an oblong-lanceolate, somewhat hyaline, pilose scale less than 1 mm in length. Second glume somewhat pubescent, 5- or 7-nerved, usually acute, the margins somewhat inflexed over the flowering glume. Flowering glume lanceolate, glabrous, as long as the second empty glume.

GUAM, Cabras Island, *Nelson 520* (type) April 24, 1919, near the seashore. The same species is represented by *J. Guerrero 471*, collected on rocks at Anaw Point, July 26, 1916.

This species manifestly belongs in the small group of Polynesian ones discussed by Stapf following his description of *Digitaria pacifica* which includes *D. pacifica* Stapf, from Christmas Island; *D. stenotaphrodes* Stapf, which extends from the Caroline Islands to the Paumotu Archipelago; and *D. platycarpha* Stapf, from Bonin Islands. These species, as Stapf has indicated, form a well-marked natural group which seems to be peculiar to the Pacific islands. To this group may also be added *Digitaria mariannensis* Merr., the type of which was also from Cabras Island, Guam, but which differs radically from the other species mentioned above in its entirely different habit; in its small size; in its paired spikes; and in being ciliate-pilose. The group is well characterized by its very greatly reduced or obsolete first glume, the spikelets generally consisting of a single empty glume with the flowering glume and its palea. *Digitaria robinsonii* is well characterized in the group by its numerous spikes.

CYPERACEAE

SCLERIA Linnaeus

SCLERIA LITHOSPERMA (Linn.) Sw. Prodr. (1788) 18.

GUAM, Nasso River, *Nelson 308*, March 21, 1918, common along the banks of the river. A common pantropic species not previously recorded from Guam.

COMMELINACEAE

ANEILEMA R. Brown

ANEILEMA VITIENSE Seem. Fl. Vit. (1865) (73) 312, *t. 96*, var. **PETIOLATA** C. B. Clarke in DC. Monog. Phan. 3 (1881) 220.

GUAM, back of Sinajana, *Nelson 413*, January 1, 1919, in damp places at the base of limestone cliffs. The Philippines, Moluccas, and Polynesia.

LEGUMINOSAE

SERIANTHES Bentham

SERIANTHES NELSONII sp. nov.

Arbor alta, partibus junioribus et inflorescentiis et fructibus ferrugineo-pubescens; foliis circiter 20 cm longis, pinnis 12- ad 20-jugis, foliolis circiter 30-jugis, oblongis, obtusis, circiter 5 mm longis; floribus paucis, cylindraceis, breviter pedicellatis, corollae tubo circiter 12 mm longo, lobis lanceolatis, 5 ad 6 mm longis; leguminis circiter 12 cm longis, 2 ad 2.5 cm latis.

A large tree reaching a height of over 20 meters and a trunk diameter of nearly 2 meters, the younger parts, inflorescences, and fruits ferruginous-pubescent. Branches terete, grayish or brownish. Leaves up to 23 cm long, the petioles and rachis ferruginous-pubescent, the latter usually with a prominent gland between the bases of each pair of pinnae; pinnae 12 to 20 pairs, 5 to 7 cm long; leaflets 25 to 30 pairs, oblong, obtuse, about 5 mm long and 2 mm wide, the upper surface glabrous, the lower paler and sparingly pubescent. Flowers few, pink, their pedicels pubescent, stout, 2 mm long or less. Calyx cylindric, pubescent, about 7 mm long, the lobes ovate, acuminate, about 1.5 mm long. Corolla pubescent, cylindric, the tube about 12 mm long, the lobes lanceolate, acuminate, recurved, 5 to 6 mm long. Mature pods about 12 cm long, 2 to 2.5 cm wide, densely ferruginous-pubescent, the valves faintly constricted between the seeds, almost woody; seeds hard, shining, smooth, brown, flattened, elliptic, about 1 cm long, 8 mm wide.

GUAM, Upe District and hills back of Abu, *Nelson s. n., 23, 34, 240* (type), in flower in July and in fruit in December, local name *hayun lago*.

This very characteristic species is readily distinguishable in the genus by its small leaflets and its relatively narrow pods. It was originally collected in the Upe District, and regarding its occurrence there Mr. Nelson writes as follows:

> The *hayun lago* is a very large and beautiful tree found at Upe at the northern end of the Island, and from what I could ascertain is

very scarce. The native name *hayun lago* means foreign wood, and would indicate that the tree is an introduced one in Guam. Few of the natives have ever seen the species. I saw two trees standing close together with trunks perhaps 6 feet in diameter, and a height of from 60 to 70 feet.

EUPHORBIACEAE

EUPHORBIA Linnaeus

EUPHORBIA MACGILLIVRAYI Boiss. in DC. Prodr. 15[2] (1862) 26.

GUAM, *Nelson 406,* December, 1918, on rocks along the Atautauo road.

The species has previously been reported only from Australia. It is also represented by *Volkens 102* (in part) from Yap, Caroline Islands, this number having been identified by Volkens as *Euphorbia serrulata* Reinw. My sheet of this number presents two distinct species; the softly pubescent one I here refer to Boissier's species, while the glabrous form may be a robust form of *Euphorbia serrulata* Reinw.

STERCULIACEAE

MELOCHIA Linnaeus

MELOCHIA VILLOSISSIMA (Presl) comb. nov.

Riedleia villosissima Presl Rel. Haenk. 2 (1835) 146.
Melochia hirsutissima Merr. in Philip. Journ. Sci. 9 (1914) Bot. 113.

GUAM, *McGregor 456* (type of *Melochia hirsutissima* Merr.), *Nelson 353,* in ravines back of Piti, October and December.

The type of *Riedleia villosissima* Presl was from Guam, but the species was overlooked by me in preparing the manuscript of my first paper on the Guam flora. Presl's description applies unmistakably to the species described by me as *Melochia hirsutissima,* the description apparently having been based on the uppermost and younger leaves.

FLACOURTIACEAE

XYLOSMA Forster f.

XYLOSMA NELSONII nom. nov.

Flacourtia integrifolia Merr. in Philip. Journ. Sci. 9 (1914) Bot. 115, non *Xylosma integrifolium* Clos.

GUAM, *Nelson 274, 322,* March and December, 1918; *Guam Experiment Station 466,* July, 1912.

Additional material with young fruits shows this species to belong in the genus *Xylosma* rather than in *Flacourtia* where it was originally placed.

RUBIACEAE

HEDYOTIS Linnaeus

HEDYOTIS FRUTICULOSA (Volk.) comb. nov.

Oldenlandia fruticulosa Volk. in Engl. Bot. Jahrb. 31 (1901) 475.

GUAM, *Nelson 268*, in small damp ravines at Santa Rosa, March, 1918. The third species of the genus from Guam, the specimen agreeing closely with *Volkens 72* and *171* from Yap, cotype material of the species.

TIMONIUS (Rumph.) de Candolle

TIMONIUS NITIDUS (Bartl.) F.-Vill. Novis. App. Fl. Filip. (1880) 109.

Petesia nitida Bartl. in DC. Prodr. 4 (1830) 395.

The original description is short and was based on material collected by Haenke "in insulis Philippicis et Marianis." A part of the original collection is preserved in the Bernhardi herbarium at the Missouri Botanical Garden, an examination of which shows that the species is different from any of the rather numerous forms definitely known from the Philippines, but that this cotype material exactly matches several recent collections from Guam. I accordingly assume that the Philippine locality cited in the original description is erroneous and that the actual specimens came from Guam. It is represented by the following specimens: *Guerrero 762*, *Nelson 16*, *138*, *361*, collected at Behia, Masso, and near Piti, where it grows in thickets in ravines and along streams. The local names recorded are *sumac lada* and *maholoc layu*.

COMPOSITAE

BLUMEA de Candolle

BLUMEA LACINIATA (Roxb.) DC. Prodr. 5 (1836) 436.

GUAM, *Nelson 338*, in damp places near Abu, December, 1918. The second species of the genus to be found in Guam, doubtless introduced. Tropical Asia and Malaya.

SEVENTH CONTRIBUTION TO THE COLEOPTERA FAUNA OF THE PHILIPPINES

By W. SCHULTZE

Of Manila, P. I.

ONE PLATE AND ONE TEXT FIGURE

In this paper I wish to make known some species of Coleoptera from Surigao Province, Mindanao, and from the small islands Dinagat, Siargao, and Bucas Grande located off the northeastern shores of Mindanao. Comparatively little entomological collecting has been done in Mindanao and the smaller islands near it. The material herein described was collected by two of the Bureau of Science botanical collectors and my entomological collector, during the months of April, May, and June, 1919. The principal collecting was carried on in the vicinity of the town of Surigao. Several trips were made to a locality hereinafter called Iron Deposit. This region has been known for some time as a remarkable locality, geologically as well as botanically. It is located some 40 kilometers southeast of the town of Surigao near the settlement of Taganito. The soil at that locality is heavily charged with iron oxide, and in the near vicinity are also found deposits of coal, iron,[1] copper, and gold. Two remarkable pitcher plants are found there abundantly, at low and medium altitudes, these being *Nepenthes truncata* Macf. and *N. merrilliana* Macf., both being among the representatives of the genus with the largest pitchers known; a smaller species, *N. alata* Blanco, is also abundant. Five to six days were spent on each of the islands of Dinagat, Siargao, and Bucas Grande. A comparatively large number of species and specimens, considering the time spent there, was collected at all of the above-mentioned localities, due undoubtedly to the favorable season; during certain seasons of the year the last-mentioned islands are almost unreachable by boats, due to their being exposed to the full sweep of the monsoons across the Pacific. A very noteworthy feature among a number of species from the above localities is the fact that a species from Siargao, the larger island,

[1] Pratt, W. E., and Lednicky, V. E., Philip. Journ. Sci. § A 10 (1915) 335.

is represented or replaced on the smaller islands by a nearly related species or subspecies. In the case of the species, the close relation to the one from Mindanao or to that from the smaller islands is clearly observable, the characters based on the sculptural structure and the colored markings being similar to a greater or less degree, but sufficiently distinct to be considered as a separate species.

Among the species collected are a few long-known species, originally described as from the "Manillas" or just Philippines. The following are worth mentioning:

Doliops geometrica Waterh. from Surigao, Surigao, Mindanao. The specimens before me agree well with Westwood's [2] figure of this species.

Doliops curculionoides Waterh. from the same locality.

Euchirus dupontianus Burm. This species I recorded before from Baganga, Davao, Mindanao. Now Surigao and Bucas Island may be added. A male from the last-mentioned locality has the black lateral stripes on the elytra very faintly pronounced except near the shoulder where the same are expanded and spotlike. Length, 74 millimeters; width at shoulder, 32; length of anterior femur, 48; length of anterior tibia, 48.

Again, the question of mimicry suggests itself due to the very apparent superficial aspect on account of similarity in markings and patterns among a large number of species herein described.

The following species are herein described:

LONGICORNIA

Euclea tagala subsp. *rufofasciata* subsp. nov.
Euclea siargaona sp. nov.
Acronia ? decimaculata sp. nov.
Doliops siargaoensis sp. nov.

CURCULIONIDÆ

Pachyrrhynchus virgatus sp. nov.
Pachyrrhynchus ardentius sp. nov.
Pachyrrhynchus absurdus sp. nov.
Pachyrrhynchus signatus sp. nov.
Metapocyrtus (*Orthocyrtus*) *insulanus* sp. nov.
Metapocyrtus (*Orthocyrtus*) *malayanus* sp. nov.
Metapocyrtus (*Orthocyrtus*) *consobrinus* sp. nov.
Metapocyrtus (*Orthocyrtus*) *ornatus* sp. nov.
Metapocyrtus violaceus sp. nov.
Metapocyrtus bucasanus sp. nov.
Metapocyrtus (*Trachycyrtus*) *multisquamosus* sp. nov.
Rhinoscapha merrilli sp. nov.
Alcides figuratus sp. nov.
Alcides adversarius sp. nov.
Alcides arenatus sp. nov.
Alcides plagiatus sp. nov.

[2] Cab. of Orient. Entom. (1848) 60, pl. 29, fig. 6.

LONGICORNIA

Euclea tagala Heller subsp. rufofasciata subsp. nov. Text fig. 1, *b*.

Shiny bluish black. The punctation less pronounced than in *E. tagala* Heller,[3] from Davao, Mindanao (text fig. 1, *c*). The markings very similar to those of the latter, except the fascia at the middle of the elytra which is narrow at the suture and extends to the lateral margin where it becomes expanded and spotlike, and from which a branch extends obliquely forward toward the scutellum. Only the middle fascia is white; all other markings are pale red.

Length, 18.5 millimeters; width, 5.8.

MINDANAO, Surigao Province, Surigao. Type in my collection.

FIG. 1. Three forms of *Euclea;* × 1.5. *a, Euclea siargaona* sp. nov.; *b, Euclea tagala* Heller subsp. *rufofasciata* subsp. nov.; *c, Euclea tagala* Heller.

A species related to *E. tagala* Heller is the following:

Euclea siargaona sp. nov. Text fig. 1, *a*.

Dark bluish black, less shiny than the preceding subspecies, all markings snow white. Front of head coarsely and irregularly punctured, with two large oblong spots, the area between the latter raised, forming a ridge. Another spot behind the eye. Vertex evenly punctured. Antenna bluish black, the basal third of the third joint and the basal half of the fourth white tomentose. Prothorax one-sixth broader than long. Rather densely punctured, the punctures small discally, but coarse toward the lateral margins. A broad anterior and posterior marginal band. Elytra densely punctured, the punctures near the base and toward the lateral margins very coarse. A stripe extending from the base near the shoulder obliquely to the lateral margin. A large subtriangular spot located just behind the scutellum at the suture, from which an oblique stripe extends on each elytron to the lateral margin, at which place this stripe

[3] Heller, Abh. Mus. Dresden 7 (1899) No. 8, 6.

becomes confluent with a band extending across the elytra slightly behind the middle. Parallel to the last-mentioned band, another at the apical fourth. Apical triangle with a large triangular spot. Underside, a spot laterally at the prothorax, mesothorax, and metathorax. First abdominal segment with a white marginal fringe, the following segments with a spot at the lateral margins.

Length, 18.6 millimeters; width, 6.

SIARGAO ISLAND. Type in my collection.

Doliops siargaoensis sp. nov. Plate I, fig. 11.

Dark brown, with a metallic greenish sheen and pale yellowish green tomentose markings. A medial stripe on head from the front to the vertex. Prothorax as long as broad, with an anterior and two posterior submarginal grooves. A narrow band slightly before the middle across the disk, from one lateral margin to the other. Elytra basally rather densely and coarsely punctured, the punctation toward the apex sparser and finer. A large suboval spot at the base. Slightly before the middle a combination of bands forming a triangle. At the apical third, one spot near the suture and another at the lateral margin. Posterior of each spot a short stripe, one subsutural and one submarginal not quite reaching each other at the apical triangle. Mesothorax and metathorax laterally with a large spot, also first abdominal segment. The following segments, except the last, each with a small spot laterally.

Length, 13 millimeters; shoulder width, 5.

SIARGAO ISLAND. Type in my collection.

Acronia ? decimaculata sp. nov. Plate I, fig. 17.

Shiny bluish black, with pale reddish brown tomentose spots. Front irregularly punctured, with a fine medial carina and an oblong bifid tomentose spot. The carina continued to the vertex, but as a fine groove. First joint of antenna sparsely punctured, third to eleventh joints black pubescent, the fourth joint with the basal half white tomentose. Prothorax longer than broad, impunctate discally, scatteredly punctured toward the lateral margins. An oval tomentose spot laterally near the posterior margin. Elytra sparsely and scatteredly punctured, the punctures coarser toward the middle, but toward the apex very small. The area at the middle very finely but densely black pubescent. Elytra with ten tomentose spots, two of which are located at the suture—a large one just behind the scutellum, the other at the apical fourth—and four on each elytron, two of these

at the lateral margin, one dorsally at the basal third, and the other at about the apical third. Margin at the apex white tomentose. Prosternum pale reddish tomentose, a large spot laterally on the mesosternum and the metasternum and a very large triangular spot laterally at the first abdominal segment. Fourth abdominal segment with a small spot laterally, and fifth with a large spot. Femora irregularly punctured, tibiæ and tarsi finely and densely black pubescent.

Length, 18 millimeters; width, at shoulder, 7.

MINDANAO, Surigao (my collector). Type in my collection.

I have placed this species provisionally in the above genus, with which it agrees in many characters; but on account of its longer legs it probably will have to be separated as soon as both sexes can be examined.

CURCULIONIDÆ

Pachyrrhynchus virgatus sp. nov. Plate I, fig. 1, ♀.

Shiny black, impunctate, except the rostrum. In general form similar to *P. venustus* Waterh., although somewhat stouter in build than the latter, with reddish golden spots, which are strongly opalescent if seen at a certain angle. Rostrum finely and scatteredly punctured, slightly divergent toward the apex, at the middle abruptly set off, the basal half with a broad depression and a fine medial line. Front with a large roundish spot, and a small squarish spot below the eye. Prothorax with a round spot laterally, at the middle between anterior and posterior margins, and another larger spot at the lateral margin. Each elytron with two large basal oval spots, one discally, the other laterally; three spots about the middle, one a round spot discally laterad, another more laterally, and a large oval spot at the lateral margin. A bifid round sutural spot beyond the middle and another smaller sutural spot at the apical fourth. Obliquely posteriorly, and laterad to the large sutural, another large round spot. Between this spot and the large oval spot at the lateral margin usually another small spot is present in the female. Another spot near the lateral margin at the apical triangle. In some specimens a very small spot is located posterior to the discal basal spot. Apical sutural termination of the elytra not obtusely pointed as in *P. venustus* Waterh.

Male, length, 17.5 millimeters; width, 6.5. Female, length, 18 millimeters; width, 7.8.

MINDANAO, Surigao Province, Surigao (my collector). Types in my collection.

Specimens were also collected on Dinagat Island, and these show no appreciable variation from those from Surigao. However, the species was not collected on Siargao and Bucas Islands, but it appears as if the above species is replaced or represented in the last-mentioned islands by a form which I shall designate as

Pachyrrhynchus virgatus subsp. insulanus subsp. nov.

Uniformly shiny black, without any spots or markings. In general form, stouter in build than *P. virgatus*, and the elytra appear more inflated and more broadly rounded apically.

SIARGAO and BUCAS ISLANDS (my collector).

A careful search made on numerous perfect specimens for traces of scales or spots resulted negatively.

Pachyrrhynchus ardentius sp. nov. Plate I, fig. 7, ♀.

Glossy, glowing, purplish red with pale green markings and spots. Rostrum as broad as long, a strongly pronounced cross groove at the middle, from which there extends to the front a shallow depression, the lateral edges of which are strongly raised. Front densely and finely punctured. Sides of head with a scale spot. Prothorax slightly broader than long, with a posterior submarginal groove. A small triangular scale spot at the middle laterad, and a large oblong patch at each lateral margin. Elytra with very faint traces of rows of punctures. Each elytron with the following markings: Three spots at the base, one of which, near the lateral margin, is large and oblong; at the middle a small spot discally and a band extending laterally; along the margin a large oblong spot, almost confluent with a small triangular spot at the apex; beyond the middle at the suture a small spot; another sutural spot near the apex. Between the last-mentioned spots, somewhat laterad, a long dash; and laterad of the latter two other spots. Femora with a scale spot apically below.

Length, 16.5 millimeters; width, 7.8.

SIARGAO ISLAND (my collector). Type in my collection.

The spots on the elytra in this species seem to vary, since in the above-described type, the only perfect specimen I received, the second basal spot on the left elytron is absent.

Pachyrrhynchus absurdus sp. nov. Plate I, figs. 3, 3*a*, ♀; fig. 4, ♂.

Dark, glossy, glowing red, with bands of pale green scales. The sexes pronouncedly different from each other in general form and in markings on the prothorax. Rostrum sparsely punctured, with a strongly pronounced, oblong depression from the middle extending to the front, where it becomes shallow. The depres-

sion with an oblong pale green scale spot. Another spot at each side of head. Prothorax slightly broader than long, with an indistinct anterior submarginal groove and a strongly pronounced posterior submarginal groove. Male with two stripes discally, from the anterior to the posterior margin, which at the anterior margin are confluent, forming an arrow point. At the lateral margin another pair of stripes forming an irregular oval. Female with a pair of subparallel bands across the disk, from one lateral margin to the other. Elytra of male oval, one-fourth longer than broad, at the apex rounded; of female one-half longer than broad, apically terminating in a prolonged thorn, which is slightly bent downward. Elytra in both sexes punctate-striate. Female with two pairs of subparallel bands across the disk from one lateral margin to the other, and at the apical third another band forming a triangle. The basal pair of bands interrupted at the suture but confluent along the lateral margin. The anterior and posterior bands of the second pair are curved backward at and near the lateral margin, and they recurve so as to form the triangular figure apically. In the male the basal pair of bands is confluent subsuturally, forming an irregular, oval figure. A scale spot on each femur near the apex, below. Posterior femora of female not reaching beyond the apex of the elytra; in the male reaching well beyond the latter.

Male, length, 12 millimeters; width, 5.5. Female, length, 15.8 millimeters; width, 6.8.

BUCAS ISLAND (my collector). Types in my collection. This species was also collected on Dinagat and Siargao Islands. The markings on the prothorax discally are variable, particularly in the male, being sometimes broader. This species is truly remarkable on account of the great differentiation between the characters of the sexes, and of the first occurrence of its kind in the genus *Pachyrrhynchus*.

Pachyrrhynchus signatus sp. nov. Plate I, fig. 6, 6*a*.

Dark, glossy, iridescent, violet purplish with pale green markings, rostrum and legs metallic copper colored. Closely related to *P. erichsoni* Waterh. Head with a small scale spot under each eye. Prothorax with a narrow anterior marginal band, another somewhat broader band at the middle interrupted discally, and traces of a posterior marginal band. Elytra with rows of distinct punctures. Each elytron with two large oblong-oval spots near the base, one located discally, the other at the lateral margin; at the middle a crossband, reaching from the first row of punctures to the eighth near the lateral margin.

At the apical third a longitudinal stripe, at the third interstice, reaching to the apex, recurving as a submarginal stripe, thus forming roughly a triangle, inside of which are located two oblong spots at the fifth and seventh interstices, respectively.

Length, 11.6 millimeters; width, 5.5.

SIARGAO ISLAND (my collector). Type in my collection.

Metapocyrtus (Orthocyrtus) insulanus sp. nov. Plate I, fig. 8, ♀.

Shiny black, with pale greenish yellow markings. Rostrum densely and confluently punctured, with an indistinct shallow depression and a squarish scale spot. Prothorax slightly broader than long, scatteredly and coarsely punctured, and with a posterior submarginal groove. A narrow anterior and posterior marginal band and an oblong spot at the middle extending toward each lateral margin. A large patch at lateral margin, confluent with anterior and posterior marginal bands. Elytra irregularly striate-punctate, the punctures somewhat coarser in the male. Each elytron with the following markings: Two basal spots, one discal and the other, a larger one, at the lateral margin; at the middle, a band which is more or less interrupted so as to form a cross row of spots; at about the apical third another cross row of three squarish spots, and laterad of the last mentioned two long dashes; along the lateral margin a long stripe which expands into a triangular spot at the apex; between the latter and the last-mentioned cross row of three spots, a subsutural dash. Femora with an irregular scale spot apically. Posterior femora of the female not reaching to the apex of the elytra; of the male, reaching beyond.

Male: Length, 14 millimeters; width, 5.8. Female: Length, 15.8 millimeters; width, 6.5.

SIARGAO ISLAND (my collector). Types in my collection.

Numerous specimens of this species were collected in Siargao Island and they seem to vary very little; however, the species was not found on Bucas nor on Dinagat.

Metapocyrtus (Orthocyrtus) malayanus sp. nov. Plate I, fig. 2, ♀.

Related to *O. schönherri* Waterh.; black, with pale greenish, metallic scale spots. Rostrum irregularly and confluently punctured; a cross groove at the base, and at the basal half a medial groove, which extends to the front. The latter sparsely and scatteredly punctured. Prothorax rather coarsely, irregularly confluently punctured, an anterior and posterior submarginal groove, and a fine medial groove which disappears some distance

from the posterior margin. At the anterior margin a narrow band of scales, at the middle laterad a roundish scale spot, and another oblong spot at the lateral margin. Elytra irregularly punctured in rows. The punctation similar to that in *O. schönherri* but somewhat denser. Each elytron with the following spots: Two at the base, one dorsally, the other at the lateral margin. At the middle a cross row of two spots, one dorsally, the other laterally. An oblong spot at the lateral margin. At the apical half a series of four or five spots; one of which, dorsally, has a tendency to become bifid, and two smaller spots between the latter and the oblong marginal spot. A subsutural spot is sometimes present, located posteriorly to the bifid spot. Another spot at the apical triangle. Mesosternum and metasternum with a spot laterally. Abdominal segments sparsely and scatteredly setose, more pronounced in the male. Femora with a scale spot near the apex, sparsely punctured and setose, tibiæ more pronouncedly setose. Femora of the male reaching beyond the apex of the elytra.

Male, length, 14.5 millimeters; width, 6. Female, length, 15.5 millimeters; width, 7.

MINDANAO, Surigao and Iron Deposit (my collector). Types in my collection.

Several specimens collected on Dinagat differ from the above, in as much as the punctures on the prothorax are still more confluent, almost coriaceous; in one specimen the spots are nearly absent. No specimens were collected on Siargao Island. This species is easily distinguished from *O. schönherri* Waterh., which I received from Paracale, Ambos Camarines Province, Luzon, by its smaller size, different sculpture—particularly on the prothorax—and smaller spots. The second cross row of spots on each elytron consists of only two in *malayanus* but three in *schönherri.*

From Bucas Grande Island numerous specimens were received, which represent a rather distinct local form of the above species and which I shall designate as

Metapocyrtus (Orthocyrtus) subsp. **atratus** subsp. nov.

Entirely glossy black, punctures on the rostrum, prothorax, and elytra sparser and less pronounced.

None of the specimens shows any trace of scales. The subsp. *atratus* represents a parallel to *Pachyrrhynchus virgatus* subsp. *insulanus* subsp. nov., together with which it was collected from the same plants.

Metapocyrtus (Orthocyrtus) consobrinus sp. nov. Plate I, fig. 5, ♀.

Black with pale green scale markings. Related to *O. malayanus* sp. nov. Rostrum densely confluently punctured. At the base a broad, rather indistinct depression, with a scale spot, not separated by a well-defined cross groove from the front, the depression extending to the latter. Front with an indistinct medial groove, scatteredly punctured, the punctures finer toward the vertex. Prothorax broader than long, greatest width before the middle, strongly coriaceous, with anterior and posterior submarginal groove. A narrow band at the anterior and posterior margins, interrupted at the middle. A small roundish scale spot toward each lateral margin and a large oblong spot at each lateral margin. Elytra punctured in irregular rows, the punctures denser and much coarser than in *O. malayanus*. Each elytron with the following spots: Three oblong spots at the base, one located dorsally, and two at the lateral margin. A cross row of three spots at the middle, having a tendency to form a band; an oblong spot at the lateral margin; at the apical third three spots, two of which are elongated dashes; another slender, dash-like spot subsuturally, and an oblong spot at the apical triangle. Lateral margins apically sparsely setose. Underside and legs irregularly sparsely punctured and rugose and sparsely setose.

Male, length, 13.3 millimeters; width, 5.6. Female, length, 14.8 millimeters; width, 6.8.

MINDANAO, Surigao, Iron Deposit (my collector). Types in my collection.

This species is easily distinguished from *O. malayanus* by its smaller size and the different sculpture, particularly of the prothorax.

Metapocyrtus consobrinus seems to be very variable as far as the spots are concerned. Among the material collected are some specimens which are uniformly black.

The males of this species, as well as of *malayanus* and other related species of *Orthocyrtus*, are easily differentiated from the females by the following characters: The elytra of the females are longer and much more inflated dorsolaterally than in the males; since the prothorax in both sexes is relatively subequal, the males show a much slenderer aspect. In species of the subgenus *Orthocyrtus* the posterior femora of the males extend beyond the apex of the elytra, whereas in the subgenus *Homa-*

locyrtus[4] the reverse is the case; that is, the posterior femora of the female extend beyond the apex of the elytra.

Metapocyrtus (Orthocyrtus) ornatus sp. nov. Plate I, fig. 12, ♂.

Black with pale green and golden scale markings. Rostrum strongly coriaceous, an indistinct cross groove at the base. Basal half of the rostrum with a large, squarish, shallow depression extending to the front, bearing an irregular spot of reddish golden scales. Front with a medial groove. Prothorax subglobular, coriaceous; an anterior and posterior submarginal groove; an anterior marginal band of reddish golden scales. A medial groove bearing a scale stripe extending from near the anterior to near the posterior margin, toward each lateral margin a broader scale stripe, and at the lateral margin a large oblong spot. Elytra coarsely and rather densely punctured in irregular rows in the male; in the female the punctures are less pronounced and more regular. Each elytron with a broad irregular band at the base, spotlike and expanded near the suture. Another band at about the middle interrupted at the suture, and posterior of the latter another irregular band. The band at the middle confluent with a marginal stripe, which extends to the apical triangle and becomes confluent with a subsutural stripe. The posterior crossband, which terminates near the lateral margin, confluent with another shorter stripe at the apical third. Between the latter and the subsutural stripe two irregular spots. The black areas of the prothorax and elytra with scattered, purplish metallic scales. Legs sparsely and irregularly punctured, and rugose and sparsely setose. Scattered reddish metallic scales on the femora near the apex and on the tibiæ. Mesosternum and metasternum of the male with a patch of brown pubescence.

Male, length, 14.5 millimeters; width, 6.2. Female, length, 12 millimeters; width, 5.6.

DINAGAT ISLAND (my collector). Types in my collection.

Two other specimens from Siargao Island (male and female), the only ones collected, differ from the above in not having the dorsolateral stripes on the prothorax, but a roundish scale spot, located at the middle, between the anterior and posterior margins.

[4] Numerous specimens of several remarkable species of this difficult subgenus were collected from the different localities; these will be considered on another occasion.

Metapocyrtus violaceus sp. nov. Plate I, figs. 9 and 9*a*, ♀.

Black, with a narrow anterior marginal line on the prothorax and a broad basal and postmedial fascia on the elytra, consisting of violet scales. The fascia in the female iridescent violet with a metallic luster. Rostrum irregularly punctured, abruptly set off at the base by a well-pronounced cross groove. A medial groove in the basal half which extends to the front. The latter with a few scattered scales. Prothorax slightly longer than broad, greatest width before the middle, strongly coriaceous in the female, less pronounced in the male. An anterior and posterior submarginal groove. Elytra of female coarsely, irregularly punctured near the suture, confluently toward the lateral margin. Besides the above indicated fascia the female has, at the middle of the lateral margin, an irregular scale spot. The elytra of the female posteriorly, laterally compressed, the posterior slope at the suture produced, the latter forming a distinct ridge. Elytra of the male coarsely punctured in fairly regular rows, posterior decline evenly rounded. Apically the margins in both sexes finely setose. Legs castaneous, sparsely punctured and finely setose.

Male, length, 12 millimeters; width, 4.5. Female, length, 13.5 millimeters; width, 5.3.

SIARGAO ISLAND (my collector). Types in my collection.

Metapocyrtus bucasanus sp. nov. Plate I, fig. 10, ♀.

Black, with bluish white scattered scales. Head, prothorax, and elytra similar in form and sculpture to *M. violaceus* sp. nov. in both sexes, but in form stouter in build, particularly the female, the elytra of which are not compressed posteriorly laterally. Prothorax with an anterior marginal line, the lateral margins of the former with numerous scattered scales. Elytra also with scattered scales, which are condensed in certain places, apparently forming indistinct spots or patches, namely, in both sexes basally and at apical third; in the female two other small indistinct spots located at the middle, one subsuturally, the other at the lateral margin. Apically, the lateral margins as well as the suture finely setose. Legs castaneous, sparsely punctured, and finely setose.

Male, length, 12 millimeters; width, 4. Female, length 13.5 millimeters; width, 5.8.

BUCAS ISLAND (my collector). Types in my collection.

Metapocyrtus (Trachycyrtus) multisquamosus sp. nov. Plate I, fig. 13, ♀.

Black, with creamy white scales, rather uniformly scattered on the prothorax, but on the elytra arranged in irregular spots. Rostrum sparsely and irregularly punctured and scantily setose; at the base constricted and set off by a strongly pronounced cross groove. Basal half with a well-pronounced medial groove, continued to the front. Prothorax indistinctly variolosely punctured, its greatest width before the middle. Elytra of female with irregular rows of coarse punctures and numerous spots of scales, located mostly at the interstices; of male with more regular rows of very coarse punctures, the interstices forming distinct ridges. Legs irregularly and sparsely punctured and setose. Hind femora of female reaching well beyond apex of elytra; hind femora of male reaching about half the length of elytra, beyond apex of the latter.

Male, length, 9 millimeters; width, 3.8. Female, length, 11 millimeters; width, 4.8.

SIARGAO ISLAND (my collector). Types in my collection. Numerous specimens were collected, but only from the above locality.

Rhinoscapha merrilli sp. nov. Plate I, fig. 16, ♀.

Black, covered with scales of various shades of greenish colors. Rostrum and prothorax as well as legs light greenish blue. Lateral margins of prothorax, a large patch on each elytron basally, also apically along the lateral margin, light yellowish green. Underside very light green, opalescent. Rostrum densely and irregularly punctured, a smooth longitudinal ridge at the middle bare of scales. Antennal groove terminating just before eye. Antenna with the second funicular joint longest, club black. Prothorax densely and irregularly punctured, except a median stripe, the latter with a groove anteriorly. Each elytron with nine longitudinal ridges which are connected by irregular cross ridges, thus forming large and strongly pronounced, squarish depressions. At the base and near the lateral margins and apex the longitudinal ridges are less pronounced; the cross ridges are absent, thus forming a large irregular patch at the base and near the apex. The patches vary individually.

Male, length, 17.8 millimeters, with rostrum; width at shoulder, 5.5. Female, length 20.8 millimeters, with rostrum; width at shoulder, 6.8.

MINDANAO, Surigao, Iron Deposit (my collector). Types in my collection. This species was found feeding on *Ixonanthes longipedunculata* Merr., also a new species, and a genus new to the Philippine flora.

Several specimens of this species were collected on Biliran Island, near Leyte, by my friend R. C. McGregor. Since *R. merrilli* is the first species of this genus to become known from the Philippine Islands, I wish to call attention to Heller's [5] remarks concerning the range or locality distribution and expansion of *Rhinoscapha* in comparison with the expansion of the pachyrrhynchids.

Alcides figuratus sp. nov. Plate I, fig. 15.

Subcylindrical, black, with creamy white bands. Related to *A. catanduanensis* Schultze. Rostrum sparsely and irregularly punctured in the basal half. Front with a well-pronounced depression. Vertex of head very finely punctured. Prothorax strongly coriaceous. A broad anterior submarginal band, interrupted at the middle, extending to the prosternum; another posterior marginal band, also interrupted at the middle. Elytra striate-punctate, the punctures rather coarse, particularly at the basal half. A combination of bands forming the figure Λ extending from the suture behind the scutellum to before the middle and to the margin. Another crossband beyond the middle reaching from one lateral margin to the other, a short branch extending forward at the suture. Apical triangle with a V-shaped marking. Legs finely and sparsely punctured.

Length, 15.5 millimeters, without rostrum; width, 5.8.

DINAGAT ISLAND (my collector). Type in my collection.

Another nearly related species is the following:

Alcides adversarius sp. nov. Plate I, fig. 14.

Subcylindrical, shiny black, with creamy white bands. Prothorax irregularly punctured, the punctation toward the base and lateral margins gradually coarser and confluent. An anterior submarginal oblong spot laterally, and a band at the posterior margin, interrupted at the middle, expanded and spotlike discally, extending to the lateral margin. Elytra striate-punctate, the punctures much finer than in *A. figuratus*. At the basal half a crossband, which is spotlike and expanded at the suture and extends in a curve to the lateral margins. Beyond the middle another crossband, interrupted at the suture, ex-

[5] Philip. Journ. Sci. § D 7 (1912) 298.

tending in a slight curve also to the lateral margins. Apical triangle with a large V-shaped marking.

Length, 13.5 millimeters, without rostrum; width, 5.3.

SIARGAO ISLAND (my collector). Type in my collection.

Numerous specimens of this species were collected, but only from the above locality.

Alcides arenatus sp. nov.

Subcylindrical, very slender, reddish brown. Rostrum relatively short; densely, irregularly, and confluently punctured. Prothorax very coarsely granulose, except the anterior submarginal area, and sparsely tomentose. Elytra very regularly punctate-striate, the punctures very large and squarish, the interstices forming regular ridges. Legs rather coarsely and confluently punctured and sparsely tomentose.

Length, 11 millimeters, without rostrum; width, 3.5.

SIARGAO ISLAND (my collector). Type in my collection.

This interesting species is easily recognized among any of the other Philippine species of *Alcides* by its very slender structure, peculiar sculpture, and coloration.

Alcides plagiatus sp. nov. Plate I, fig. 18.

Shiny black, with large creamy white spots. Rostrum with a fine groove in the basal half; dorsally sparsely and finely punctured, laterally coarsely. A shallow depression on the front, which bears a punctiform impression. Prothorax finely and regularly punctured, strongly and uniformly inflated dorsolaterally, near the anterior margin laterally constricted. At the constriction an oblong spot; another roundish spot located at the base laterad. Elytra very finely striate-punctate. Each elytron at the base with a depression reaching from the roundish and projecting scutellum to the humeral angle, the basal margin rounded, bent upward and slightly overlapping the prothorax. Another depression at the apical decline. Each elytron with the following spots: A large, suboval sutural spot at the base, another large roundish spot before the middle at the lateral margin, a roundish subsutural spot in the apical half, laterad of the latter a smaller roundish spot, and a V-shaped spot at the apical triangle. Prosternum, mesosternum, and metasternum creamy white; abdominal segment laterally with a series of creamy white spots.

Length, 16.5 millimeters, without rostrum; width, 6.5.

LUZON, Ilocos Norte Province, Mount Palimlim (my collector). Type in my collection.

This species seems to be related to *A. schuetzei* Schultze, but in general appearance it represents an intermediate form between the first and second group of Philippine *Alcides* species which I indicated in a former paper.[6]

ENTOMOLOGICAL REMARKS

A very recommendable contribution to the knowledge of the Coleoptera of the Philippines [7] has just come under observation. Since this author states in his paper, that the number of species of Philippine Anthribidæ has grown to more than 60, I wish to call attention to the fact that in my catalogue of Philippine Coleoptera [8] are recorded 67 species and subspecies; this number together with those of Doctor Heller brings the number up to nearly 100 species. My catalogue contains 2,449 species and subspecies of Philippine Coleoptera; an additional list of over 400 species has since accumulated, which will be published at a future date.

[6] Philip. Journ. Sci. § D 13 (1918) 269.

[7] Heller, K. M., Philippinische Anthribidæ, *Tidjsch. voor Entomol.* (Dresden) 61 (1918) 242. (February 15, 1919.)

[8] A Catalogue of Philippine Coleoptera. Manila (1915.)

ILLUSTRATIONS

[Drawn by W. Schultze.]

PLATE I

FIG. 1. *Pachyrrhynchus virgatus* sp. nov., female.
2. *Metapocyrtus* (*Orthocyrtus*) *malayanus* sp. nov., female.
3. *Pachyrrhynchus absurdus* sp. nov., female; 3*a*, lateral view, elytron, female.
4. *Pachyrrhynchus absurdus* sp. nov., male.
5. *Metapocyrtus* (*Orthocyrtus*) *consobrinus* sp. nov., female.
6. *Pachyrrhynchus signatus* sp. nov., female; 6*a*, lateral view.
7. *Pachyrrhynchus ardentius* sp. nov., female.
8. *Metapocyrtus* (*Orthocyrtus*) *insulanus* sp. nov., female.
9. *Metapocyrtus violaceus* sp. nov., female; 9*a*, lateral view, elytron.
10. *Metapocyrtus bucasanus* sp. nov., female.
11. *Doliops siargaoensis* sp. nov.
12. *Metapocyrtus* (*Orthocyrtus*) *ornatus* sp. nov., male.
13. *Metapocyrtus* (*Trachycyrtus*) *multisquamosus* sp. nov., female.
14. *Alcides adversarius* sp. nov.
15. *Alcides figuratus* sp. nov.
16. *Rhinoscapha merrilli* sp. nov., female.
17. *Acronia* ? *decimaculata* sp. nov.
18. *Alcides plagiatus* sp. nov.

TEXT FIGURE

FIG. 1. Three forms of *Euclea*, × 1.5.
a, *Euclea siargaona* sp. nov.
b, *Euclea tagala* subsp. *rufofasciata* subsp. nov.
c, *Euclea tagala* Heller.

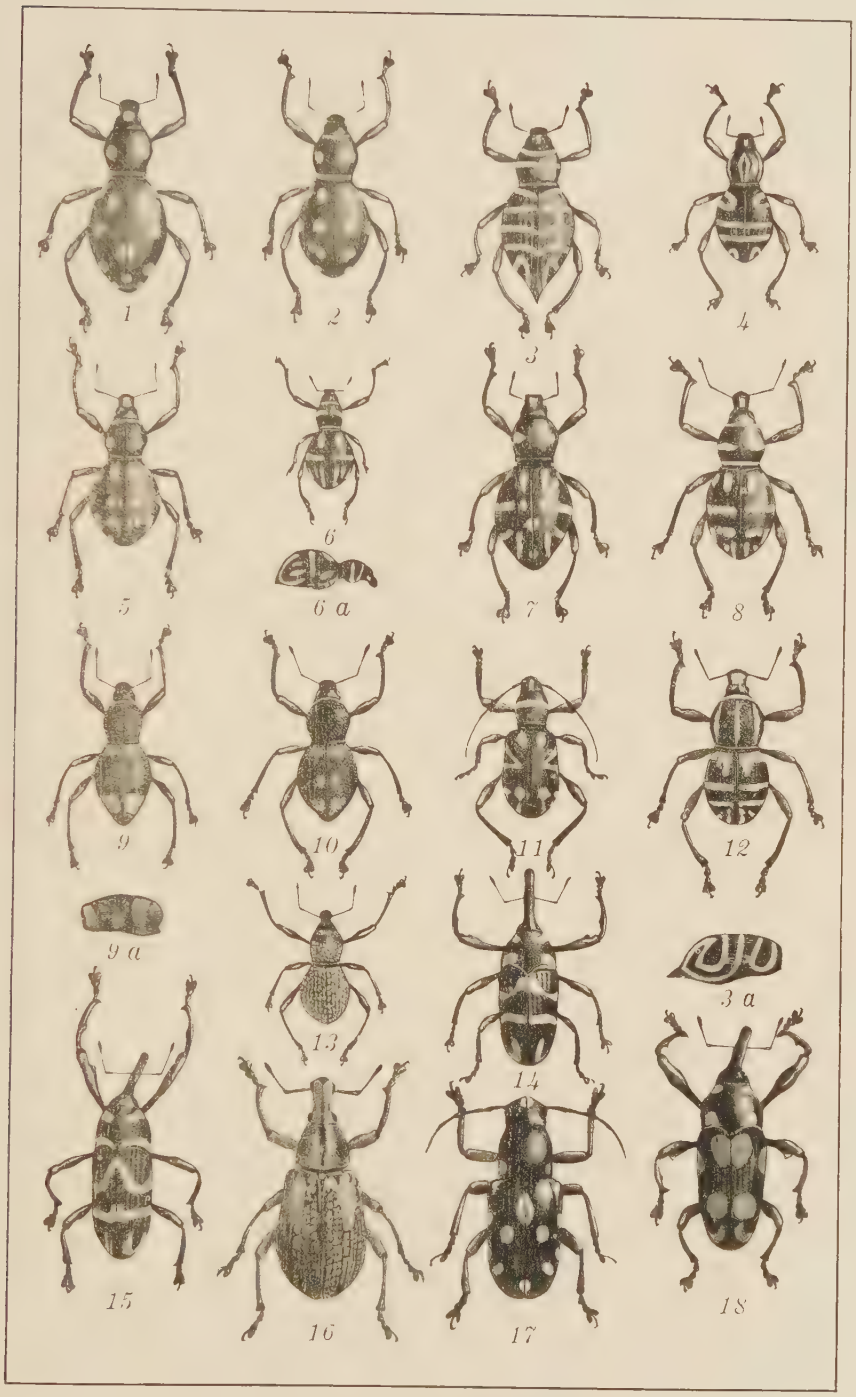

PLATE I. NEW PHILIPPINE COLEOPTERA.

A CASE OF ACUTE MANIA ASSOCIATED WITH PLASMODIUM VIVAX INFECTION [1]

By FRANK G. HAUGHWOUT, PEDRO T. LANTIN, and RICARDO FERNANDEZ

Of the University of the Philippines, and of the Philippine General Hospital

ONE TEXT FIGURE

The case cited here is deemed worthy of note because it is one of the comparatively small number of cases recorded where infection with *Plasmodium vivax* has been associated with cerebral symptoms and death. Parasites were present in the peripheral circulation in small numbers only and the temperature of the patient at no time rose higher than 39° C., that point being reached a few hours before death. Prior to that time the fever did not rise above 38° C., this elevation coming several days after the onset of an acute mania.

The patient was one of a series of cases that was being experimentally treated with Roentgen rays for splenomegaly of malarial origin, the results of which work will be reported in another paper. He received only one irradiation, and that eight days before the development of the mental disturbance which ran its course and terminated in death eight days following its onset. At no time did the patient show any indication of injury that it seemed possible to trace to the Roentgen rays, and the necropsy failed to reveal any such evidence.

The subject was a male Filipino, 19 years old, unmarried, and a waiter by occupation. He was born in Iloilo and had resided in Manila for three months. About a year before his admission to the Philippine General Hospital he had gone to Davao where he had stayed for three months. During his stay in that place he had chills, fever, and headache every day during a period of almost two months. These symptoms recurred intermittently after his departure from Davao, and also continued following his arrival in Manila.

Physical examination made by Dr. Wenceslao Vitug of the house staff, showed the patient to be a poorly developed, poorly

[1] Contribution from the departments of parasitology and medicine, University of the Philippines and Philippine General Hospital.

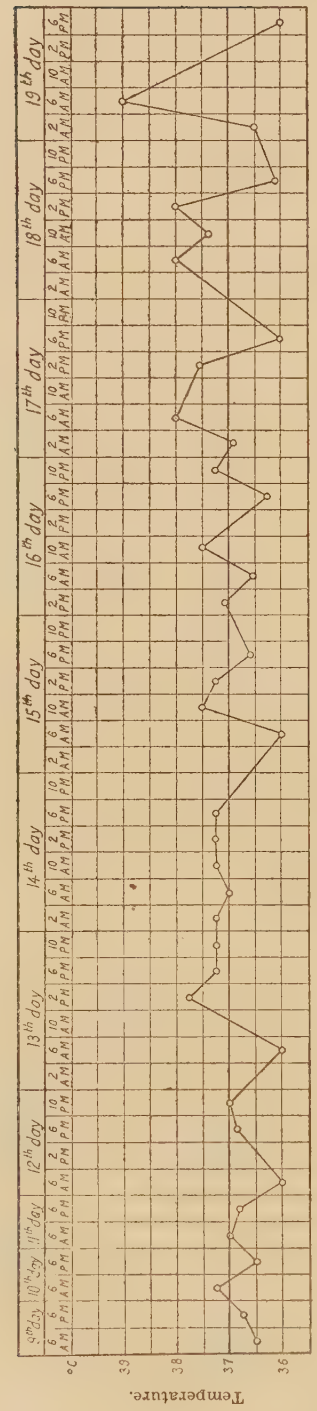

FIG. 1. Temperate chart of patient from ninth to nineteenth day.

nourished individual, pale and anæmic. The neck bore the scars of an operation for the removal of cervical glands. The lungs and the circulatory and digestive systems were apparently normal. There was marked splenomegaly, the lower margin of the spleen being traceable 10 centimeters below the left costal margin. The organ was hard and smooth to the touch.

Microscopic examination of the fæces revealed an infection with *Ancylostoma duodenale.* The urine was normal. Total erythrocyte count was 4,750,000. Hæmoglobin not estimated. The total leucocyte count was 9,200, the microscopist reporting "66 per cent polymorphonuclear neutrophiles, 26 per cent small lymphocytes, and 8 per cent eosinophiles." Examination of the blood later in the day by one of us (F. G. H.) failed to disclose any parasites. There was, however, an unusual amount of free pigment on the slide. While it is our practice to make note of such a finding, undue stress is not laid on it when the subject is a Filipino, or a member of another dark-skinned race.

The following morning, just before the patient was sent to the X-ray room, the blood was examined again, and one rather distorted parasite was found after a long search. The spleen was then irradiated, the procedure being as follows:

Coolidge tube.
Distance from targ. to skin, 30 centimeters.
Hardness of tube, 9B.
Milliamperes, 5.
Exposure, 5 minutes.
Filter, 2.5 millimeters, alum.; 7 millimeters of leather.
Hampson radio.
Area, entire spleen.

On the afternoon of the same day we again examined the blood of the patient, and noted an increase in the mononuclears, and stippling of the erythrocytes that had not previously been reported, but no more parasites were seen until the following day, when one was discovered that was provisionally identified as *Plasmodium vivax.*

Three days later there had been no apparent reduction in the size of the spleen. Blood examination showed a mononucleosis, an eosinophilia, and marked basophilic stippling of the erythrocytes.

The delirium developed suddenly four days after that. The patient first became restless and showed evidence of some mental distress. When inquiry was made as to what troubled him, he merely pointed to his scrotum without offering any explanation as to the nature of the trouble. He was carefully examined but nothing wrong was discovered. The restlessness increased, the eyes became bloodshot, and eventually his condition lapsed into one of noisy delirium that continued night and day except at such periods when he was under the influence of opiates. He shouted and sang and finally became so violent that he had to be tied into bed. The patient bit both tongue and lips and spat bloody saliva upon all who came near him. He presented a truly pitiable if not shocking spectacle. From this time on there was no change in the mental condition of the patient who virtually wore himself out in his tumultuous delirium. He refused all food and medicine, and his physical condition accordingly declined very rapidly. On the day of the development of the first mental symptoms an unmistakable trophozoite of *Plasmodium vivax* was found in the blood.

The number of parasites in the peripheral blood increased somewhat until from four to six could be counted in 100 oil-immersion fields. All were characteristic trophozoites of *Plasmodium vivax.* We failed to discover any of the questionable ring forms or any crescent gametocytes. The patient, who had been receiving iron, quinine, and strychnine up to the time his mania developed, was put on intramuscular injections of quinine

and urea, but he failed to show the slightest beneficial effects from them except for the disappearance of the parasites from the peripheral blood. Twenty-four hours before death adrenalin was administered in the hope of forcing the parasites out of the spleen and into the circulation, but without success. Three days before death the temperature, which had varied between the subnormal and the normal, rose to 38° C., and a few hours before death it reached 39° C. The day before death, the differential leucocyte count made by one of us (F. G. H.) showed 78 per cent polymorphonuclear neutrophiles, 7 per cent lymphocytes, 14 per cent large mononuclear leucocytes, and 1 per cent eosinophiles.[2]

The patient gave no history of previous attacks of mania, and the necropsy failed to disclose any evidence of syphilis. No Wassermann test was made.

DISCUSSION

The case presented features that frankly puzzled us. In the literature available to us we can find no case that strictly parallels it. Our search for data in the literature has been somewhat complicated by the fact that many authors speak in general terms of cerebral symptoms complicating "tertian malaria" without specifying the species of parasite involved. The term is useful enough in a clinical sense, but many writers in recording results which may have to be considered by others seem to forget, for the time being, the well-known fact that tertian fever may be caused by infection with either *Plasmodium vivax* or *Plasmodium falciparum.*

We have, however, run across a few cases of recent occurrence in which the writers seem to have satisfied themselves of the occurrence of cerebral symptoms in so-called "benign" tertian fever. Among these will be found four cases reported from Macedonia by Wurtz and van Malleghem (5) and two by Hesse (2). In the report of Wurtz and van Malleghem, three of the patients developed violent delirium followed by unconsciousness; the other became cyanosed and unconscious following a period of vomiting. Both of Hesse's cases died. One developed acute cerebral symptoms which culminated in delirium on the fourth day; the other ran a course as a chronic relapsing meningitis. We have only been able to obtain these reports in abstract and therefore cannot thoroughly compare the cases. We are inclined

[2] The patient had received treatment with oil of chenopodium for his hookworm infection soon after entering the hospital.

to believe that all of them fell under treatment during the course of active malarial infection, while it must be borne in mind that ours was a chronic case showing no symptoms of active malaria. Wurtz and van Malleghem say they could find no parasite save *Plasmodium vivax;* while Hesse, according to the abstract, contents himself with speaking of his cases as being "benign" tertian, without naming the parasite. We are inclined to suspect that he was dealing with *Plasmodium falciparum* infections.

The possibility that the Roentgen rays in some manner precipitated the attack of mania might be borne in mind. We think this extremely unlikely unless their application operated to activate the parasite in some way—a thing that might possibly come to pass. However, in the short series of cases of chronic malaria that we have treated with the Roentgen rays, this is the only one that developed cerebral symptoms.

Skinner and Carson,(4) who first undertook the treatment of malaria with the Roentgen rays, report no such occurrence in their series; nor does Pais,(3) nor Deutsch,(1) who followed. Pais states his belief that new generations of the parasite appear to display exalted virulence under the influence of the rays. If this be true, we may have an explanation of the phenomena in our case, although it must be borne in mind that the parasites never were in the circulation in large numbers and that hyperpyrexia never developed.

Whatever the explanation of this strange case we can only repeat that painstaking search failed to disclose any evidence of infection with *Plasmodium falciparum,* while the parasites demonstrated in the circulating blood were unquestionably *Plasmodium vivax.*

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ILLUSTRATION

TEXT FIGURE

FIG. 1. Temperature chart of the patient infected with *Plasmodium vivax*.

REVIEWS

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Auricular fibrillation, by Louis Hamman.

A case of multiple tuberculosis in childhood, by Allen K. Krause.

Barbed Wire Disease: | A Psychological Study | of the Prisoner of War | by | A. L. Vischer, | M. D. Basle, M. R. C. S. Eng. | translated from the German, with additions by the author | with an introductory chapter by | S. A. Kinnier Wilson, | M. A., B. Sc., M. D. Ed., F. R. C. P. Lond. | and a frontispiece by | Miss E. Fortescue-Brickdale | London: | John Bale, Sons & Danielsson, Ltd. | Oxford House | 83–91, Great Titchfield Street, W. 1 | 1919 | pp. 1–84.

Cerebrospinal Fluid | in Health and in Disease | by | Abraham Levinson, B. S., M. D. | [7 lines of titles] | with a foreword by | Ludvig Hektoen, M. D. | with fifty-six illustrations, including | five color plates | St. Louis | C. V. Mosby Company | 1919 | Cloth, pp. 1–231, including index.

FOREWORD

The author was kind enough to ask me if I would look over his manuscript and then tell him whether it seemed to me worthy of publication. Later, when I told him that in my opinion he had produced a valuable little book, he requested me to state the reasons for this favorable opinion in the form of a foreword. This I can do in a few brief statements.

In the first place, on reading the manuscript, I soon became aware that the author had come to his task with not only a large experience behind him in the examination by various methods of the cerebrospinal fluid as an aid in diagnosis, but with a highly creditable record in the scientific study of this fluid as well. Evidently he had been drawn to his work on the cerebrospinal fluid because of its attractiveness as a field of research, as well as on account of its importance in diagnosis.

It is to this happy combination of true philosophic interest and first-hand practical knowledge on the part of the author that the book owes its chief merit, namely, thoroughness and freshness in the parts dealing with fundamental problems, as well as in those dealing with practical matters. In the second place there could be no doubt in regard to the timeliness of a work of this

kind. Indeed it seemed to me that a definite want would be supplied; for, in spite of an increasing importance in medicine, there was as yet no comprehensive book on all phases of the cerebrospinal fluid.

FROM THE PREFACE

Cerebrospinal fluid is of great physiologic importance for various reasons. It is the clearest and most transparent of all the fluids of the body. It is clearer than blood, than bile, and even clearer than urine, and under normal conditions experiments may be made on it without fear of clot formation or color change. Furthermore, cerebrospinal fluid, like blood and urine, can be removed from the living body without injury to the system. This gives one the opportunity of working with processes in the living body—a distinct advantage over the study of dead tissue.

From the standpoint of pathology also, cerebrospinal fluid presents an exceptional opportunity for study. The slightest change in the color of the fluid, the smallest increase in the protein content or in the cell count, all of which are easily discernible, indicate the presence of a pathologic process. One is able to follow the course of disease throughout all stages by noting the various changes the cerebrospinal fluid undergoes from time to time. These changes may be manifested not only by the presence of the causative organisms themselves, but just as frequently by specific physical, chemical, cytologic and physicochemical processes. A close study of the changes in the cerebrospinal fluid under pathologic conditions throws light, not only on the specific diseases of the nervous system, but on the condition of other systems. One can readily see, therefore, how large is the scope for the study of cerebrospinal fluid.

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